

AL. 1. 1411
C.2

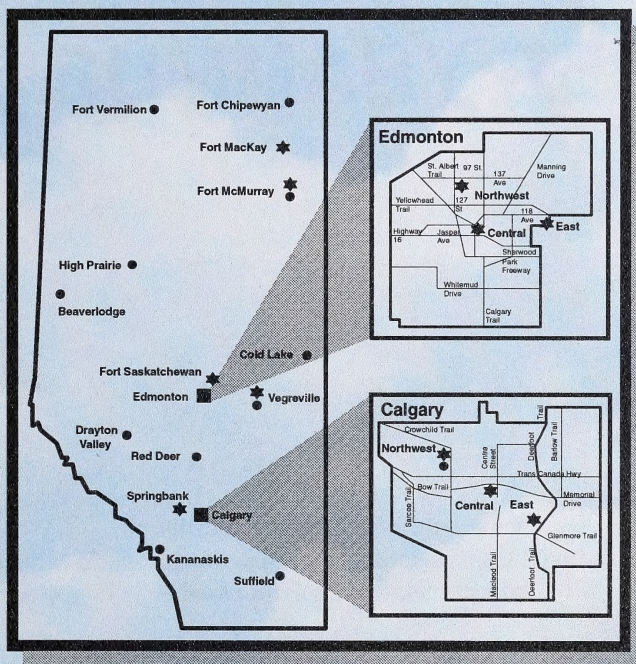
Air Quality Monitoring in Alberta

SUMMARY REPORT

1995

CANADIANA

FEB 18 1997





Digitized by the Internet Archive
in 2017 with funding from
University of Alberta Libraries

https://archive.org/details/airqualitymonit1995albe_0

Alberta Environmental Protection operates a comprehensive air and pollution quality monitoring program throughout the province. In 1995, this program consisted of 17 continuous (hourly) stations, 8 intermittent (daily) stations, 21 static (monthly) and 10 special (bi-weekly and 117 special static (hourly) stations. The following key observations are based on data collected by this program in 1995:

- Good air quality was recorded from 91.4% of the time at the four background sites, compared to 99.0% at the Calgary central station. Good air quality was also recorded over 72% of the time at the Edmonton central and Calgary east stations. In 1995, the frequency of Good air quality was 10% higher than the average from 1984 to 1994 at other major sites.

AIR QUALITY MONITORING IN ALBERTA

1995 SUMMARY REPORT

Prepared by:

R.H. Myrick and C.A. Byrne

Air Issues and Monitoring Branch
Chemicals Assessment and Management Division
Alberta Environmental Protection

November 1996

This report is one in a series of air quality annual reports produced by Alberta Environmental Protection for 1995. The following air quality annual reports are available for 1995:

**Air Quality Monitoring in Alberta: 1995 Summary Report;
Air Quality Monitoring in Alberta: 1995 Detailed Report, and
Air Quality Monitoring in Alberta: 1995 Data Report.**

For copies of these reports or for more information contact:

Air Issues and Monitoring Branch
Alberta Environmental Protection
6th Floor, Oxbridge Place
9820 - 106 Street
Edmonton, Alberta
T5K 2J6
Phone (403) 427-5893

OVERVIEW

Alberta Environmental Protection operates a comprehensive air and precipitation quality monitoring program throughout the province. In 1995, this program consisted of 11 continuous (hourly) stations, 8 intermittent (daily) stations, 31 static (monthly and tri-monthly) networks and 12 precipitation quality (weekly) stations. The following key observations are based on data collected by this program in 1995:

- Good air quality was recorded from 93.4% of the time at the Fort Saskatchewan station to 99.9% at the Calgary central station. Good air quality was also recorded over 99% of the time at the Edmonton central and Calgary east stations. In 1995, the frequency of Good air quality was higher than the average from 1986 to 1994 at most monitoring stations. An upward trend in Good air quality is evident at the Calgary central station.
- Poor air quality was recorded at the Fort Saskatchewan (5 hours), Calgary east (4 hours), Edmonton central (2 hours), Edmonton northwest (2 hours), and Edmonton east (1 hour) stations. All Poor air quality readings at the Fort Saskatchewan, Edmonton central and Edmonton northwest stations were due to exceedances of the 1-hour guideline for ozone. The majority of these exceedances were recorded on June 4 and were likely caused by the combination of naturally generated ozone with ozone produced from anthropogenic sources in the Edmonton area, and ozone associated with forest fire smoke transported from northeastern Alberta. The Poor air quality readings at the Calgary east and Edmonton east stations were due to high dust and smoke values caused by vehicle exhaust emissions during stagnant weather conditions. Poor air quality at the Edmonton and Calgary east stations was reported in September and November, respectively. Very Poor air quality was not recorded at any provincial monitoring stations in 1995.
- Annual average concentrations of carbon monoxide and nitrogen dioxide were lower than or close to the same as the average over the previous 10 years at all stations. A substantial decrease in concentrations of both of these parameters is evident in downtown Edmonton and Calgary. A downward trend in carbon monoxide is also indicated at the Edmonton northwest, Calgary northwest, Calgary east and Fort Saskatchewan stations. These downward trends are due to better emission controls imposed on vehicles over the last decade. Air quality guidelines for carbon monoxide were occasionally exceeded at Edmonton and Calgary stations located close to major traffic arteries. Guidelines for nitrogen dioxide were not exceeded at any Alberta monitoring stations. The primary source of carbon monoxide and nitrogen dioxide in Alberta cities is vehicle exhaust emissions.
- The 1-month guideline for dust and smoke (the coefficient of haze) was exceeded at the Edmonton northwest (January), Edmonton east (January) and Calgary east (November) monitoring stations. High dust and smoke values at these stations in the winter months can be attributed to vehicle exhaust emissions, traffic movement and industrial emissions coupled with a relatively high frequency of stagnant weather conditions. Annual average dust and smoke values were close to the 10-year average at most stations.
- The 1-hour guideline for sulphur dioxide was exceeded at the Fort McMurray (1 hour) and Fort MacKay (2 hours) stations. Ambient hydrogen sulphide concentrations exceeded the 1-hour guideline at the Edmonton east (5 hours), Calgary east (14 hours) and Fort MacKay (2 hours) stations. Sources of sulphur dioxide and hydrogen sulphide in the Fort McMurray and Fort MacKay areas are the oil sands plants located between the communities. Sources of hydrogen sulphide in east Edmonton are primarily petroleum storage tanks, petroleum transport vehicles and the sewage treatment plant. The major source of hydrogen sulphide in east Calgary is the sewage treatment plant.

- A downward trend in total hydrocarbons is indicated at the Edmonton northwest and east stations. A small upward trend is evident at the Calgary northwest and Fort Saskatchewan stations. Total hydrocarbons includes a broad family of chemicals which are emitted by vehicles, industrial sources and vegetation. Annual average total hydrocarbon concentrations in 1995 were close to the average over the last 10 years at all stations.
- Carbon dioxide was monitored at the Calgary central and Springbank Airport stations in 1995. Annual average values measured in 1995 were close to the average from 1991 to 1994 at these locations.
- Inhalable particulates (PM₁₀) were measured at the Edmonton northwest and Calgary central (starting in June) stations on a continuous basis in 1995. The annual average values recorded at these stations were 20.0 and 13.5 µg/m³, respectively.
- Ammonia concentrations measured at the Fort Saskatchewan station were below the detection limit of the monitoring instrument close to 99% of the time. The peak 1-hour ammonia concentration recorded at this station was 0.2 ppm which is 10% of the guideline (2.0 ppm).
- Total suspended particulates concentrations were lower in 1995 than the average from 1985 to 1994 at most stations. A substantial downward trend in total suspended particulate values is also evident at the Edmonton central, Edmonton northwest, Calgary central, Calgary northwest and Fort Saskatchewan stations. The 24-hour guideline for suspended particulates was exceeded at the Edmonton central (2 times), Edmonton northwest (2 times), Edmonton east (5 times), Calgary central (6 times) and Calgary east (17 times) stations.
- The monthly guideline for total sulphation was not exceeded in 1995. However, the monthly guideline for static hydrogen sulphide was exceeded in Sherwood Park 6% of the time. A downward trend in total sulphation is indicated at the Calgary, Camrose, Grande Prairie, Lethbridge, Redwater, Balzac, Cochrane, Crossfield, Jumping Pound, Lone Pine Creek and Okotoks networks. An upward trend in hydrogen sulphide (measured by static methods) is evident at the Coleman network.
- Total dustfall loadings exceeded the residential and industrial guidelines most frequently at the Blairmore (residential guideline exceeded 50% of the time) and Lethbridge (residential guideline exceeded 67% of the time) networks in 1995. A downward trend in annual average total dustfall values is apparent at the Blairmore, Coleman, Edmonton, Exshaw and Sherwood Park networks. Calcium loadings in dustfall samples were the highest at the Exshaw network in 1995.
- The monthly guideline for fluoride was exceeded at the Redwater network 29% of the time in 1995. High fluoride values in this area are likely due to ammonium phosphate fertilizer manufacturing operations.
- The lowest annual average precipitation pH was recorded at the Fort McMurray station in 1995 (pH of 4.8). Precipitation pH values near natural, background levels were recorded at all other precipitation quality stations (pH range from 4.9 to 5.6).
- Effective acidity, which takes into account chemical and biological processes that occur after the precipitation has entered the soil, showed lowest values at the Cold Lake station and the highest values at the Red Deer and Kananaskis stations. Potential acid input, which is the sum of basic compounds subtracted from the sum of acidic compounds in precipitation, also showed highest values at the Red Deer and Kananaskis stations.

TABLE OF CONTENTS

OVERVIEW	iii
ABBREVIATIONS	viii
UNITS OF MEASUREMENT	viii
THE INDEX OF AIR QUALITY (IQUA)	1
CONTINUOUS AIR QUALITY MONITORING	4
Ozone	5
Carbon Monoxide	7
Dust and Smoke	8
Nitrogen Dioxide	9
Sulphur Dioxide	11
Hydrogen Sulphide	12
Total Hydrocarbons	13
Carbon Dioxide	14
Inhalable Particulates	15
Ammonia	15
INTERMITTENT AIR QUALITY MONITORING	16
Total Suspended Particulates	17
Benzo (a) Pyrene	18
Sulphate	19
Nitrate	20
STATIC AIR QUALITY MONITORING	21
Total Sulphation	22
Static Hydrogen Sulphide	23
Total Dustfall	24
Calcium	25
Fluorides	25
PRECIPITATION QUALITY MONITORING	26
pH	27
Anions (sulphate, nitrate, chloride, phosphate)	28
Cations (calcium, ammonium, sodium, magnesium, potassium)	29
Effective Acidity	30
Potential Acid Input	30

ABBREVIATIONS

IQUA - index of the quality of the air

O₃ - ozone

CO - carbon monoxide

CO₂ - carbon dioxide

NO₂ - nitrogen dioxide

SO₂ - sulphur dioxide

H₂S - hydrogen sulphide

THC - total hydrocarbons

TSP - total suspended particulates

BaP - benzo (a) pyrene

VOC - volatile organic compound

PM₁₀ - particulates with an aerodynamic diameter less than 10 microns

UNITS OF MEASUREMENT

ppm - parts per million by volume

ppb - parts per billion by volume

µg/m³ - micrograms per cubic meter

µg/1000 m³ - micrograms per 1000 cubic meters

mg/day/100 sq cm - milligrams of SO₃ per day per 100 square centimeters

mg/100 sq cm/30 days - milligrams per 100 square centimeters per 30 days

µg/100 sq cm/ 30 days - micrograms of water soluble fluorides per 100 square centimeters per 30 days

kg/ha/yr - kilograms per hectare per year

COH units - coefficient of haze units measured as the reduction of light transmission per 1000 linear feet of air sample

Air Quality Monitoring in Alberta: 1995 Summary Report

In 1995, the Alberta Environmental Protection air monitoring program consisted of 11 continuous stations, 8 intermittent stations, 31 static networks and 12 precipitation quality stations. The overall objective of this monitoring program is to: **determine the status, changes and trends in selected measures of air quality in the province.** Specific objectives of the program are to:

- provide data for the assessment of existing air quality relative to air quality guidelines;
- inform the public on the status of air quality;
- monitor air quality representative of urban environments;
- report long-term trends in air quality; and
- undertake special monitoring surveys.

INDEX OF THE QUALITY OF THE AIR (IQUA)

The Index of the Quality of the Air, or IQUA, is a method of reporting air quality in terms that are easy to understand by the general public. This index associates concentrations of five major air quality parameters to provincial air quality guidelines and federal air quality objectives. The IQUA, developed by a federal-provincial committee in 1978, has been adopted by Alberta as well as other Canadian provinces.

Outdoor concentrations of carbon monoxide, dust and smoke (the coefficient of haze), nitrogen dioxide, ozone and sulphur dioxide are used to determine whether the quality of the air is Good, Fair, Poor or Very Poor. The IQUA is reported every hour, 24 hours a day, and is available from an automated telephone system by calling **427-7273** in Edmonton and **250-2099** in Calgary.

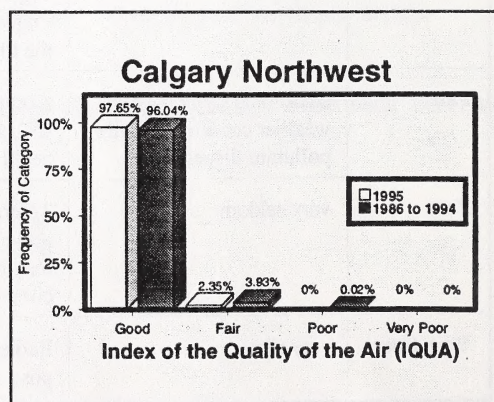
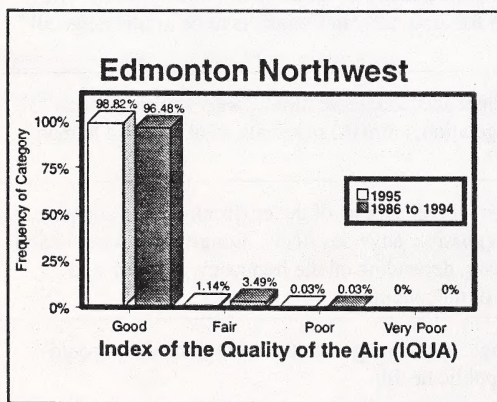
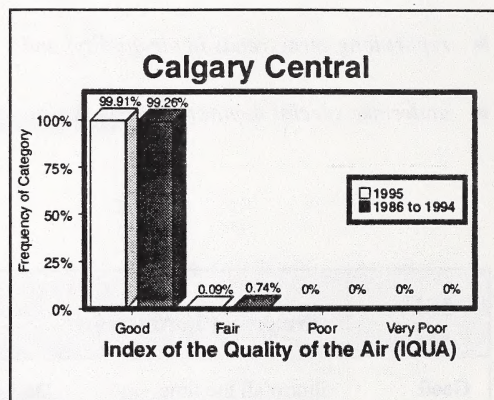
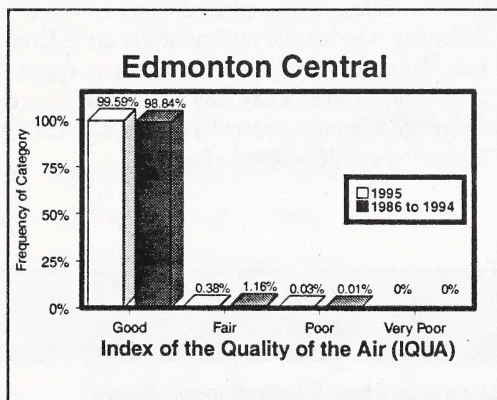
IQUA rating	Frequency in Alberta	Effects
Good	almost all the time	Desirable range: no known harmful effects to soil, water, vegetation, animals, materials, visibility or human health. The long-term goal for air quality in Canada is to be in this range all the time.
Fair	occasional (typical when weather conditions inhibit pollutant dispersion)	Acceptable range: adequate protection against harmful effects to soil, water, vegetation, animals, materials, visibility and human health.
Poor	very seldom	Tolerable range: not all aspects of the environment are adequately protected from possible adverse effects. Long-term control action may be necessary, depending on the frequency, duration and circumstances of the readings.
Very Poor	very rare	Intolerable range: in this range, continued high readings could pose a risk to public health.

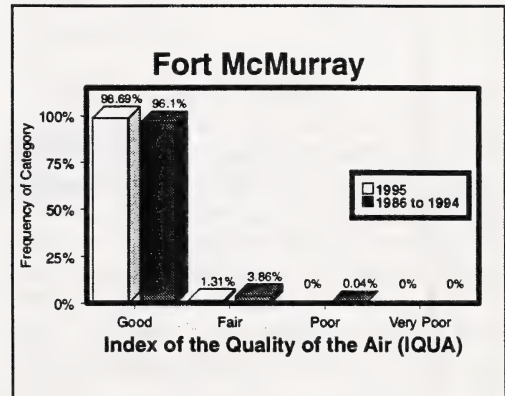
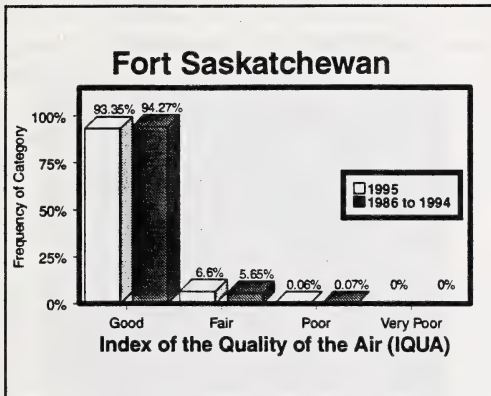
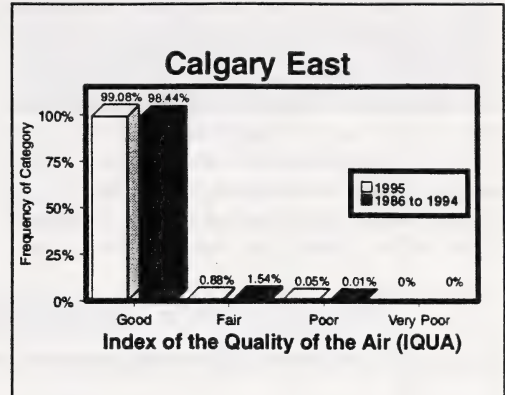
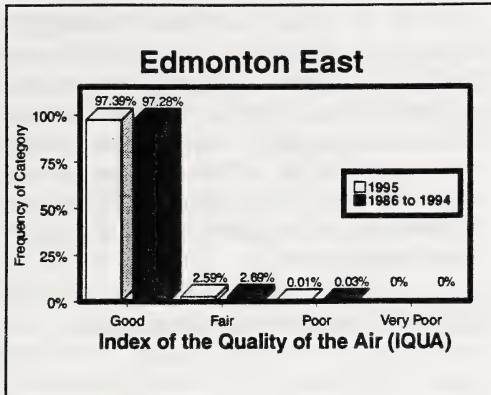
In 1995, air quality at Alberta Environmental Protection stations was Good at least 90% of the time on an annual basis. The frequency of Good air quality readings ranged from about 93% at the Fort Saskatchewan station to over 99% at the Calgary central station. Fair air quality was reported from less than 1% of the time at the Edmonton central, Calgary central and Calgary east stations to 6.6% of the time at the Fort Saskatchewan monitoring station.

Poor air quality was reported at the Edmonton central (2 hours), Edmonton northwest (2 hours), Edmonton east (1 hour), Calgary east (4 hours) and Fort Saskatchewan stations (5 hours). Most poor air quality readings at the Edmonton central, Edmonton northwest and Fort Saskatchewan

stations were caused by high 1-hour ozone concentrations recorded on June 4. These high ozone values were likely due to three contributing factors: (1) ozone generated by natural processes; (2) ozone produced from ozone precursors (oxides of nitrogen and volatile hydrocarbons) emitted in the Edmonton area; and (3) ozone associated with forest fire smoke transported from northeastern Alberta. Poor air quality at the Edmonton east and Calgary east stations were recorded on September 25 and November 15, respectively. These episodes were caused by the combination of vehicle exhaust emissions and stagnant weather conditions.

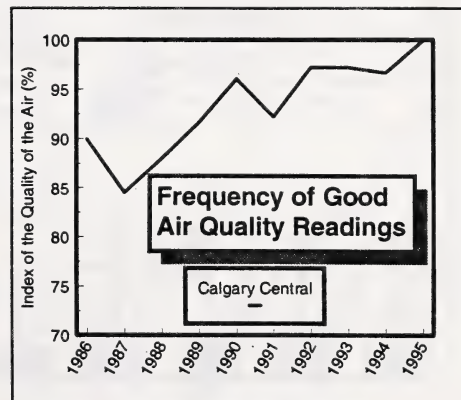
Very Poor air quality was not reported at any Alberta monitoring stations in 1995.





In 1995, Good air quality was more frequent than the 9-year average (1986 to 1994) at all Edmonton, Calgary and Fort McMurray stations. The frequency of Good air quality at the Fort Saskatchewan station was slightly lower than the average over the last nine years. However, the Fort Saskatchewan station was relocated several times over this period. Also, the frequency of Fair air quality was lower than the 9-year average at most monitoring stations.

Based on data from 1986 to 1995, an increase in Good air quality ratings is evident at the Calgary central station. A trend in the IQUA is not evident at any other monitoring stations.

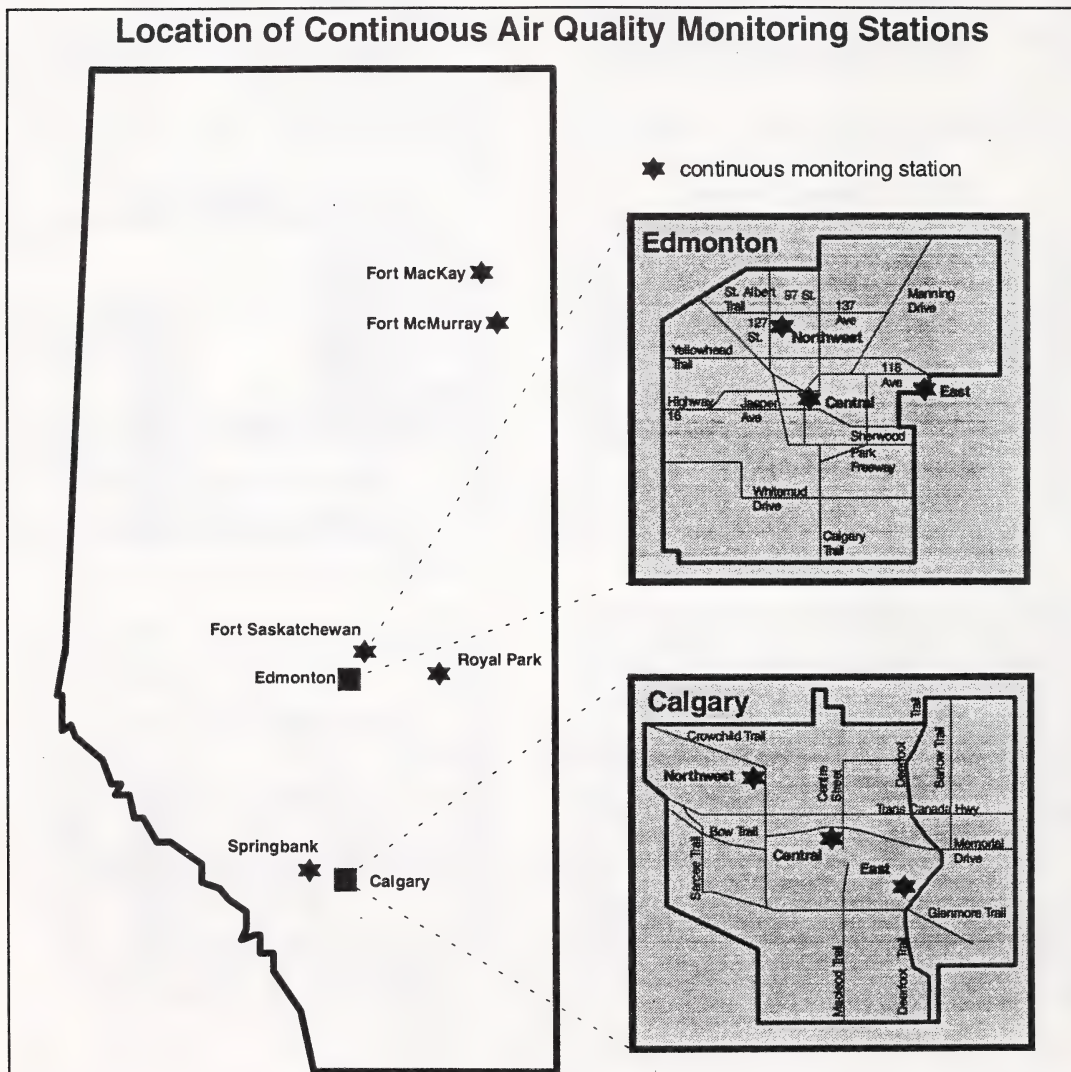


CONTINUOUS AIR QUALITY MONITORING

Air quality is monitored on a continuous basis at 11 stations located in Edmonton (3 stations), Calgary (3 stations), Fort Saskatchewan, Fort McMurray, Fort MacKay, Springbank Airport (20 km west-

northwest of Calgary) and Royal Park (10 km northwest of Vegreville). These stations report outdoor concentrations of air quality parameters on an hourly basis, 24-hours a day. Air parameters monitored at continuous stations include ozone, carbon monoxide, the coefficient of haze (dust and smoke), nitrogen dioxide, sulphur dioxide, hydrogen sulphide, total hydrocarbons, carbon dioxide and inhalable particulates.

Location of Continuous Air Quality Monitoring Stations



Ozone

At normal outdoor concentrations, ozone is a colourless, odourless gas. However, ozone does have a characteristic sharp odour when at very high concentrations, such as that associated with lightning storms.

Unlike other pollutants, ozone is not emitted directly by man's activities, but is generated by a photochemical reaction of oxides of nitrogen (NO_x) and volatile organic compounds (VOCs) in the presence of sunlight. Ozone is also transported to ground level from the upper atmosphere by natural meteorological mixing processes. Ozone and ozone precursors, such as NO_x and VOCs, may also be carried from upwind sources such as urban centres and industrial complexes. A major source of VOCs in rural areas is natural emissions from trees and vegetation. In Alberta, ozone concentrations are generally lower at urban locations than at rural locations. This is due to the destruction of ozone by nitric oxide that is emitted by vehicles.

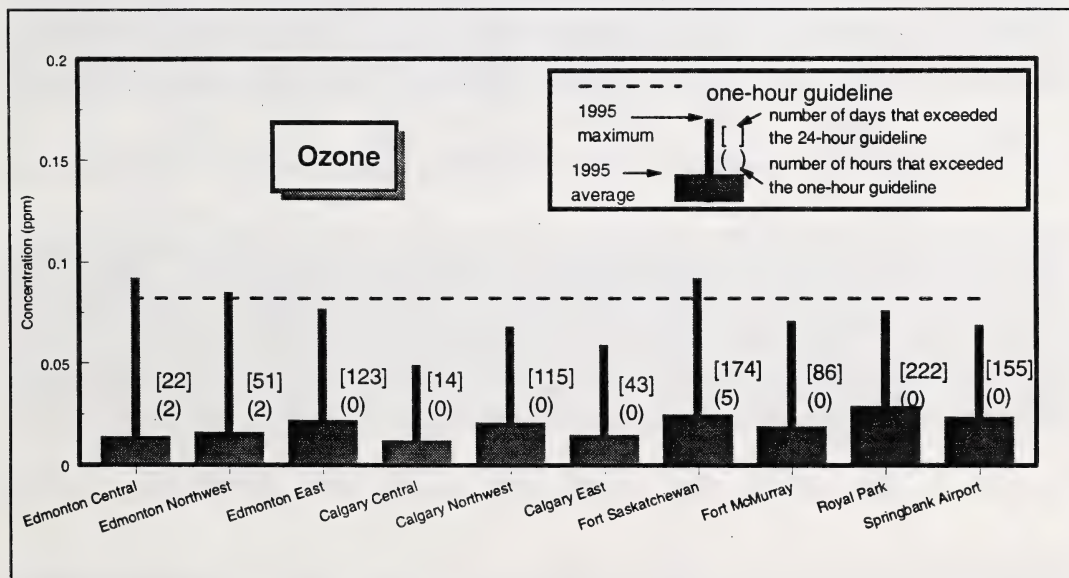
In Alberta, maximum ozone values are generally recorded during the spring and summer months at all monitoring stations. During the late spring and

summer, ozone production in the lower atmosphere is at a maximum due to a peak in incoming sunlight combined with stagnant weather conditions which may cause reactive pollutants to remain in the region for a prolonged period of time. During the early spring, high daily average ozone values may be influenced by transport of ozone from the upper atmosphere.

The guidelines for ozone are as follows:

- ▲ 0.082 ppm as a 1-hour average concentration; and
- ▲ 0.025 ppm as a 24-hour average concentration.

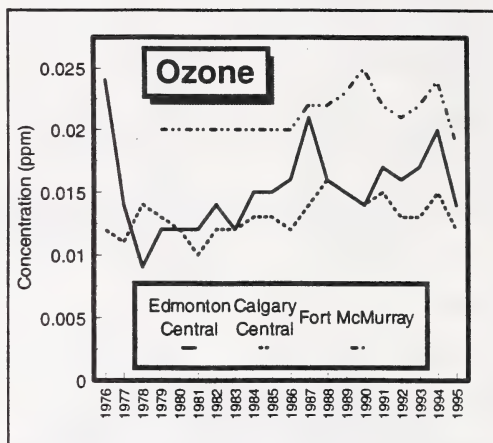
In 1995, the 1-hour guideline for ozone was exceeded at the Edmonton northwest (2 hours), Edmonton central (2 hour) and Fort Saskatchewan (5 hours) monitoring stations. The majority of these exceedances were recorded on June 4 and were likely due to the combination of ozone generated from natural sources with ozone produced from anthropogenic sources in the Edmonton area and ozone associated with smoke transported from forest fires in northeastern Alberta.



The 24-hour guideline for ozone was exceeded most frequently at rural and small urban monitoring stations such as Royal Park (near Vegreville), Fort Saskatchewan and Springbank Airport. This guideline is often exceeded at pristine locations in Alberta due to natural ozone generating processes. The 24-hour guideline for ozone is currently being reviewed by a federal-provincial committee.

Small upward trends in long-term ozone concentrations are evident from data collected at the Edmonton central, Calgary central and Fort McMurray monitoring stations. Upward trends in downtown Edmonton and Calgary are likely related to lower concentrations of oxides of nitrogen.

However, average ozone concentrations measured in 1995 were generally lower than the 10-year average (1985 to 1994) at all Alberta monitoring stations. The greatest difference in annual average ozone concentrations was at the Edmonton central station where the annual average value in 1995 was 18% lower than the 10-year average.



Annual Average Ozone Concentrations (ppm)							
Parameter	Monitoring Period	Edmonton			Calgary		
		Central	Northwest	East	Central	Northwest	East
Ozone	1995	0.014	0.016	0.022	0.012	0.021	0.015
	1985 to 1994	0.017	0.018	0.022	0.014	0.023	0.017

Parameter	Monitoring Period	Fort Saskatchewan	Fort McMurray	Vegreville	Springbank Airport
Ozone	1995	0.025	0.019	0.029	0.024
	1985 to 1994	0.024	0.022	0.027 ^a	0.028 ^b

a Average ozone for Vegreville in 1993 and 1994.

b Average ozone for Springbank in 1994.

Carbon Monoxide

Carbon monoxide is a colourless, odourless gas emitted into the atmosphere primarily by motor vehicles. Minor sources include fireplaces, industry, aircraft and natural gas combustion.

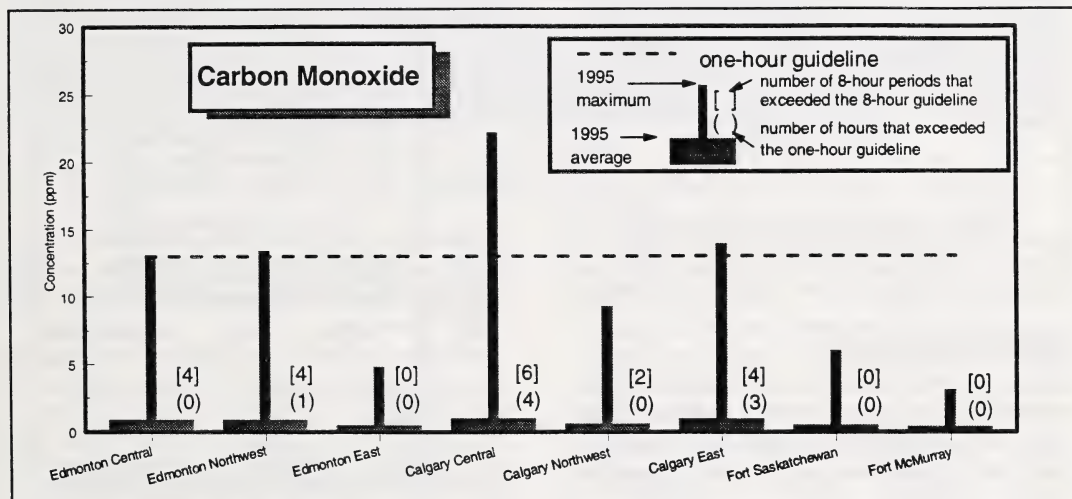
In regulating carbon monoxide, Alberta has adopted Environment Canada's most rigorous ambient air quality objectives. Maximum permissible carbon monoxide concentrations are:

- ▲ 13.0 ppm as a 1-hour average concentration; and
- ▲ 5.0 ppm as an 8-hour average concentration.

Carbon monoxide concentrations are higher at monitoring stations located close to major traffic arteries such as the Edmonton central, Edmonton

northwest, Calgary central and Calgary east stations. Maximum daily carbon monoxide values are generally observed during the morning and afternoon rush hours at these locations.

The 1-hour guideline for carbon monoxide was exceeded at the Edmonton northwest (1 hour), Calgary central (4 hours) and Calgary east (3 hours) monitoring stations. The 8-hour guideline was exceeded at the Edmonton central (4 times), Edmonton northwest (4 times), Calgary central (6 times), Calgary northwest (2 times) and Calgary east (4 times) stations. Exceedances of the guidelines for carbon monoxide were caused by the combination of vehicle exhaust emissions with strong temperature inversions and light winds.

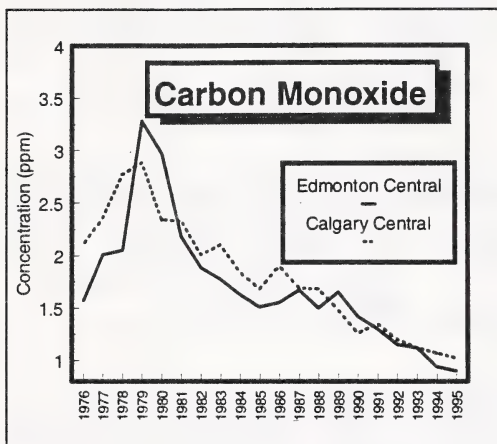


Annual Average Carbon Monoxide Concentrations (ppm)

Parameter	Monitoring Period	Edmonton			Calgary			Fort Saskatchewan	Fort McMurray
		Central	Northwest	East	Central	Northwest	East		
Carbon Monoxide	1995	0.90	0.88	0.48	1.02	0.62	0.97	0.51	0.38
	1985 to 1994	1.38	1.14	0.57	1.44	0.72	1.15	0.58	0.44

Annual average carbon monoxide values were well below the average for the last 10 years at all monitoring stations. This observation was most significant at the Calgary and Edmonton central stations where the 1995 average concentrations were from 29 to 35% lower than the 10-year average.

A significant downward trend in carbon monoxide concentrations is evident at the Edmonton central and northwest stations, all Calgary stations, and the Fort Saskatchewan station. Again, the largest downward trends are at the Edmonton and Calgary central stations.



Dust and Smoke

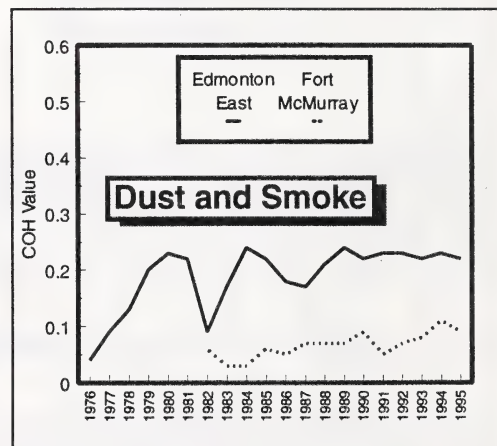
The coefficient of haze is a measurement of the amount of dust and smoke in the atmosphere. Dust and smoke may originate from vehicle emissions, road dust, wind-blown soil, industrial sources, agricultural activities, open burning, forest fires and various other sources. The guideline for dust and smoke, which is based on visibility, established by Alberta Environmental Protection is that:

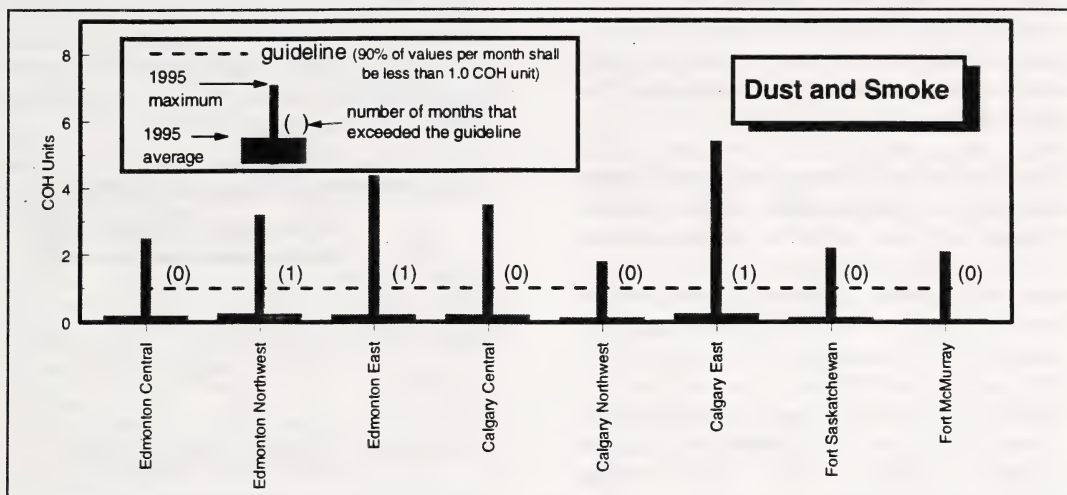
- ▲ 90% of the readings per month shall be less than 1.0 COH unit.

Dust and smoke values are generally higher at large urban stations in Edmonton and Calgary than at the small urban stations in Fort Saskatchewan and Fort McMurray. This is indicative of vehicular exhaust and traffic movement which contribute to dust and smoke in the atmosphere. Values are typically highest during the morning and afternoon rush hours during the fall and winter seasons.

The monthly guideline for dust and smoke (the coefficient of haze) was exceeded at the Edmonton northwest and east stations in January and at the Calgary east monitoring station in November. These exceedances were due to vehicle exhaust emissions and traffic movement during stagnant weather conditions.

A small increase in the long-term annual average dust and smoke values is indicated at the Edmonton east and Fort McMurray monitoring stations.





Annual Average Dust and Smoke Values (COH units)

Parameter	Monitoring Period	Edmonton			Calgary			Fort Saskatchewan	Fort McMurray
		Central	Northwest	East	Central	Northwest	East		
Coefficient of Haze	1995	0.19	0.25	0.22	0.23	0.14	0.26	0.14	0.09
	1985 to 1994	0.23	0.24	0.22	0.24	0.08	0.25	0.11	0.07

Annual average dust and smoke values in 1995 were close to the 10-year average at most stations. Dust and smoke values were higher than the 10-year average at the Calgary northwest, Fort Saskatchewan and Fort McMurray stations. The annual average dust and smoke value at the Calgary northwest station was 75% higher than the average from 1985 to 1994. Average dust and smoke values lower than the 10-year average were recorded at the Edmonton central monitoring site.

Nitrogen Dioxide

For the purposes of air quality monitoring, oxides of nitrogen is considered to be the sum of nitric oxide and nitrogen dioxide. Most oxides of nitrogen are emitted in the form of nitric oxide. Nitric oxide will rapidly react with ozone in the atmosphere to form nitrogen dioxide.

In Alberta, about 43% of oxides of nitrogen emissions are produced by transportation (aircraft and vehicles) while 37% are due to industrial sources (oil and gas industries) and 18% are due to power plants (based on 1990 emission estimates). Smaller sources of oxides of nitrogen include natural gas combustion, heating fuel combustion, and forest fires. The largest urban source of oxides of nitrogen is emissions from motor vehicles. Guidelines for nitrogen dioxide are based on prevention of human health effects. The guidelines are:

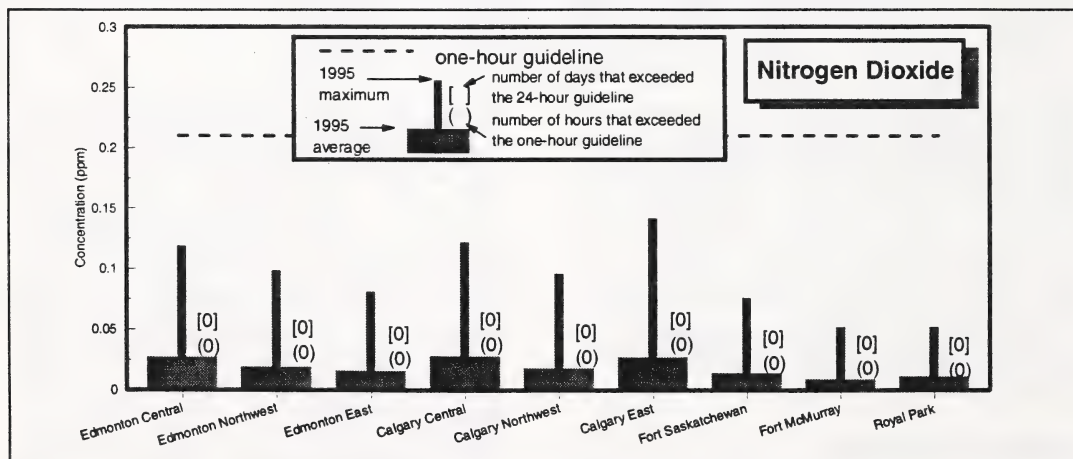
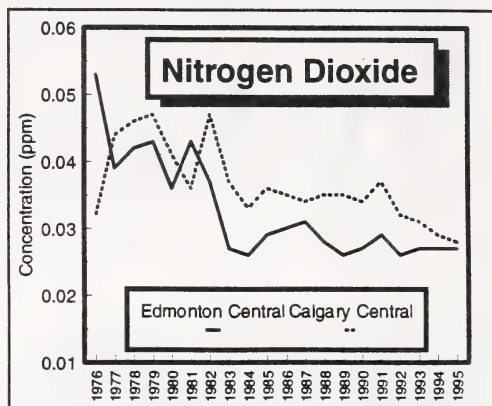
- ▲ 0.21 ppm as a 1-hour average concentration;
- ▲ 0.11 ppm as a 24-hour average concentration; and
- ▲ 0.03 ppm as an annual average concentration.

The highest nitrogen dioxide concentrations are generally recorded at the Calgary central, Edmonton central, Calgary east and Edmonton northwest stations. Sources of oxides of nitrogen in these areas are vehicle exhaust emissions and heating fuel consumption.

Maximum oxides of nitrogen concentrations are observed in the winter. This is likely due to vehicular exhaust emissions combined with persistent stable weather conditions. As with carbon monoxide and the coefficient of haze, nitrogen dioxide peaks are evident during the morning and afternoon traffic rush hours.

The 1-hour, 24-hour and annual guidelines for nitrogen dioxide were not exceeded at any Alberta monitoring stations in 1995. Annual average nitrogen dioxide and total oxides of nitrogen values show a significant downward trend at the Edmonton and Calgary central monitoring stations. This trend is due to lower emissions of oxides of nitrogen from automobiles.

Annual average nitrogen dioxide concentrations in 1995 were lower than or close to the same as the 10-year average at almost all stations. The most notable difference was at the Calgary central station where the 1995 annual average was 18% lower than the average over the previous 10 years.



Annual Average Nitrogen Dioxide Concentrations (ppm)

Parameter	Monitoring Period	Edmonton			Calgary			Fort Saskatchewan	Fort McMurray	Royal Park
		Central	Northwest	East	Central	Northwest	East			
Nitrogen Dioxide	1995	0.027	0.019	0.016	0.028	0.018	0.027	0.014	0.009	0.011
	1985 to 1994	0.028	0.022	0.018	0.034	0.018	0.027	0.012	0.009	0.008 ^a

^a Average Nitrogen Dioxide for 1994

Sulphur Dioxide

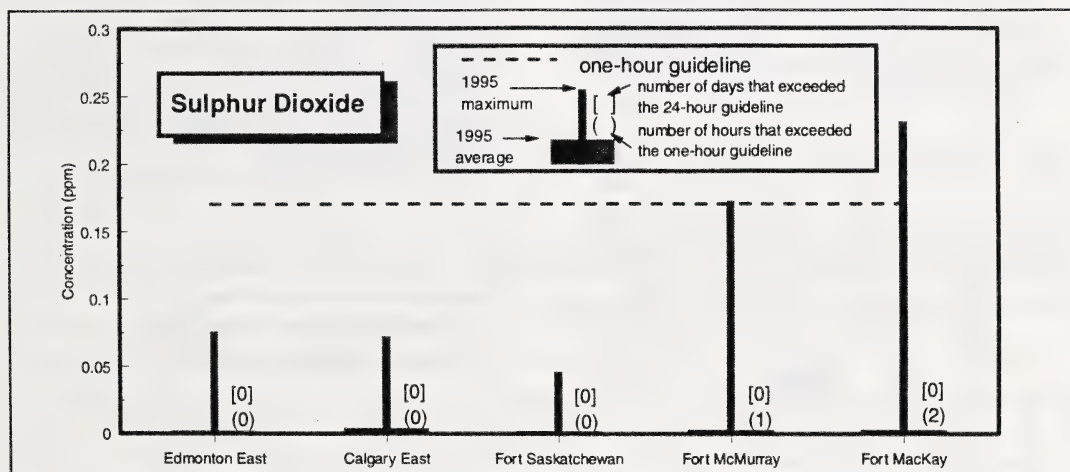
Sulphur dioxide is a colourless gas with a pungent odour. In Alberta, it is estimated that 42% of sulphur dioxide emissions are emitted by natural gas processing plants while oil sands and power plants produce about 26% and 18%, respectively (based on 1990 emissions inventory). Other sources include gas plant flares, oil refineries, pulp and paper mills and fertilizer plants.

Alberta Environmental Protection has adopted Environment Canada's most rigorous objectives for sulphur dioxide. The following guidelines are based on prevention of effects to vegetation:

- ▲ 0.17 ppm as a 1-hour average concentration;
- ▲ 0.06 ppm as a 24-hour average concentration;
- and
- ▲ 0.01 ppm as an annual average concentration.

The 1-hour guideline for sulphur dioxide was exceeded once at the Fort McMurray station and twice at the Fort MacKay station. These exceedances were due to emissions from the oil sands plants located between the two communities. The 24-hour and annual guidelines for sulphur dioxide were not exceeded at any monitoring stations in 1995. Annual average sulphur dioxide values are too low to resolve a significant trend.

Annual average sulphur dioxide concentrations were the same as the average over the last 8 years at all stations other than Edmonton east monitoring station. The annual average concentrations at the Edmonton east station was slightly lower than the average from 1987 to 1994.



Annual Average Sulphur Dioxide Concentrations (ppm)

Parameter	Monitoring Period	Edmonton East	Calgary East	Fort Saskatchewan	Fort McMurray	Fort MacKay
Sulphur Dioxide	1995	0.002	0.004	0.002	0.003	0.003
	1987 to 1994	0.003	0.004	0.002	0.003	0.003

Hydrogen Sulphide

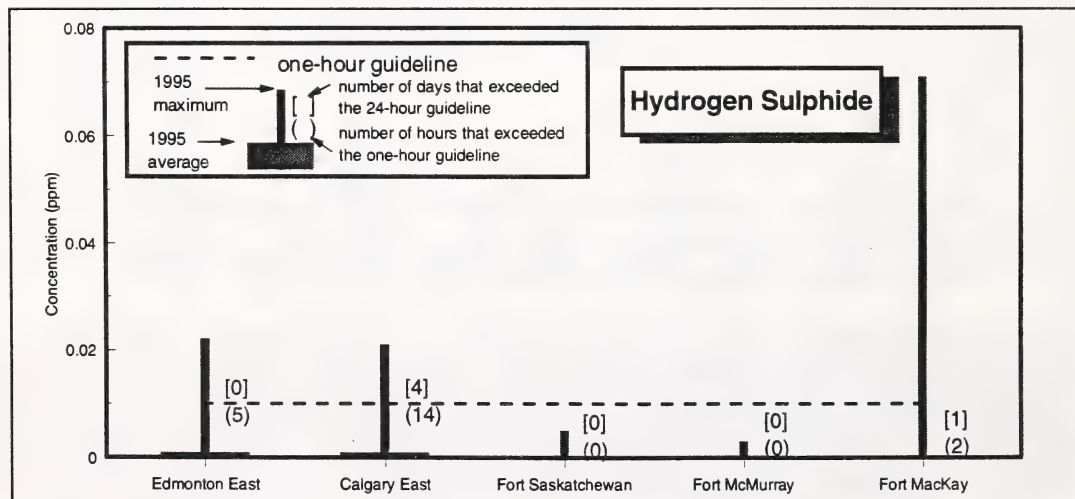
Hydrogen sulphide is a colourless gas with a rotten egg odour. Industrial sources include fugitive emissions (leakages) from petroleum refineries, tank farms for unrefined petroleum products, natural gas plants, petrochemical plants, oil sands plants, sewage treatment facilities, pulp and paper plants which use the kraft pulping process, and animal feedlots. Natural sources of hydrogen sulphide include sulphur hot springs, sloughs, swamps and lakes.

Guidelines for hydrogen sulphide are based on the odour threshold; however, some individuals can smell hydrogen sulphide at levels lower than the ambient guideline. The guidelines for hydrogen sulphide in Alberta are:

- ▲ 0.010 ppm as a 1-hour average concentration; and
- ▲ 0.003 ppm as a 24-hour average concentration.

The 1-hour guideline for hydrogen sulphide was exceeded at the Edmonton east (5 hours), Calgary east (14 hours) and Fort MacKay (2 hours) monitoring stations. The 24-hour guideline was exceeded at the Calgary east (4 days) and Fort MacKay (1 day) stations. Exceedances of the hydrogen sulphide guidelines in east Edmonton were primarily due to fugitive emissions from petroleum storage tanks, petroleum transport vehicles and the sewage treatment plant. The sewage treatment plant was the major cause of hydrogen sulphide exceedances in east Calgary. Hydrogen sulphide emissions from the oil sands plants were the source of occasional high hydrogen sulphide readings at the Fort MacKay station.

With the exception of the Fort Saskatchewan station, annual average hydrogen sulphide values were the same in 1995 as the average for the previous 10 years of monitoring. The average concentration at the Fort Saskatchewan station was lower in 1995 than the 10-year average. Annual average hydrogen sulphide values are too low to show a significant trend.



Annual Average Hydrogen Sulphide Concentrations (ppm)						
Parameter	Monitoring Period	Edmonton East	Calgary East	Fort Saskatchewan	Fort McMurray	Fort MacKay
Hydrogen Sulphide	1995	0.001	0.001	0.000	0.000	0.000
	1985 to 1994	0.001 ^a	0.001 ^b	0.001	0.000	0.000

a Average hydrogen sulphide for Edmonton east from 1991 to 1994.

b Average hydrogen sulphide for Calgary east from 1986 to 1994.

Total Hydrocarbons

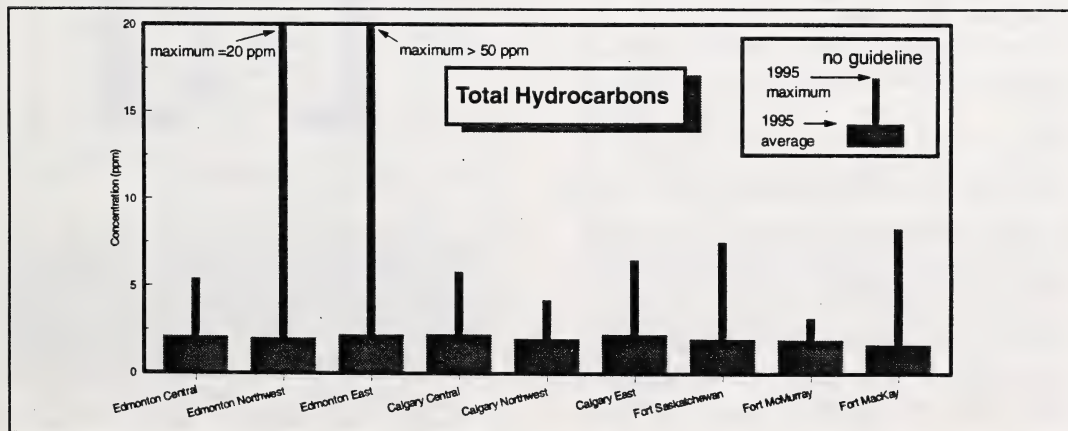
The term "total hydrocarbons" refers to a broad family of chemicals that contain carbon and hydrogen atoms. Methane, a non-reactive hydrocarbon, is the most common hydrocarbon in the earth's atmosphere. Reactive hydrocarbons such as alkenes, alkynes and aromatics are important because they can: (1) react with oxides of nitrogen in the presence of sunlight to form ozone; and (2) be toxic to humans, animals or vegetation. Sources of hydrocarbons include vegetation, vehicular emissions, gasoline marketing and storage tanks, petroleum and chemical industries, dry cleaning, fireplaces, natural gas combustion and aircraft traffic. Alberta does not have guidelines for ambient (outdoor) concentrations of total hydrocarbons.

Hydrocarbon concentrations are highest in the winter months at monitoring stations which are located close to major traffic arteries. In downtown Edmonton and Calgary, maximum hydrocarbon

values are observed during the morning and afternoon rush hours. Vehicles are the major source of hydrocarbons at urban locations.

The highest hydrocarbon concentrations were generally reported at the Edmonton northwest and Edmonton east monitoring stations in 1995. A maximum hourly value of greater than 50 ppm was recorded at Edmonton east station in September. Relatively high hourly values in east Edmonton were likely related to fugitive emissions from petroleum transport vehicles and petroleum storage tanks.

In 1995, average hydrocarbon concentrations were close to the 10-year average at all monitoring stations. The greatest difference was observed at the Edmonton central station where the annual average in 1995 was 9% lower than the average for the previous 10 years. Natural background hydrocarbon concentrations range from 1.5 to 2.0 ppm.

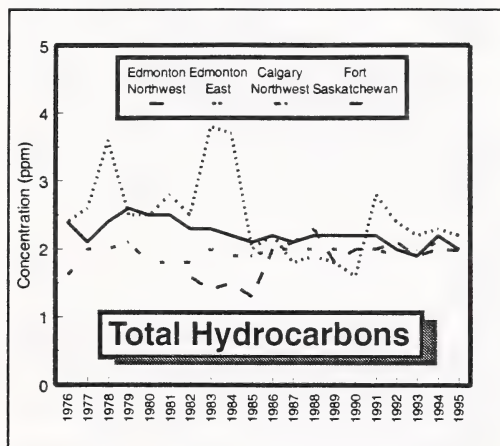


Annual Average Total Hydrocarbon Concentrations (ppm)

Parameter	Monitoring Period	Edmonton			Calgary			Fort Saskatchewan	Fort McMurray	Fort MacKay
		Central	Northwest	East	Central	Northwest	East			
Total Hydrocarbons	1995	2.1	2.0	2.2	2.2	2.0	2.2	2.0	2.0	1.7
	1985 to 1994	2.3	2.1	2.1	2.2	2.0	2.1	2.0	1.9	1.8 ^a

a Average total hydrocarbons for Fort MacKay from 1987 to 1993.

Based on annual average values, a long-term downward trend in total hydrocarbons is evident at the Edmonton northwest and east stations. A slight upward trend in total hydrocarbons is indicated at the Calgary northwest and Fort Saskatchewan stations.

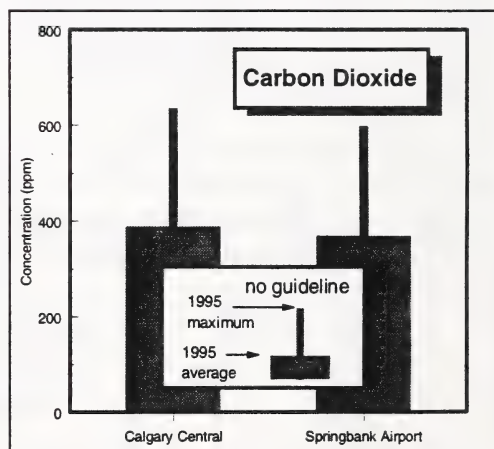


Carbon Dioxide

Carbon dioxide is a colourless, odourless, non-toxic gas that is produced by man through the combustion of fossil fuels. Some natural sources of carbon dioxide include volcanos, forest fires, and the respiration processes of micro-organisms and plants. Carbon dioxide emissions comprise over half of the greenhouse gases emitted by man. At the present time, guidelines do not exist for ambient levels of carbon dioxide.

Alberta Environmental Protection monitors carbon dioxide in downtown Calgary and the Springbank Airport (20 km west-northwest of downtown

Calgary). Average concentrations of carbon dioxide at the Calgary central and Springbank Airport stations in 1995 were 389 and 369 ppm, respectively. These values are similar to those recorded from 1991 to 1994. Higher carbon dioxide concentrations were generally recorded in the fall and winter at the Calgary central station and during the summer at the Springbank Airport station. The major source of carbon dioxide in downtown Calgary is fossil fuel combustion. Typical carbon dioxide values at pristine locations are about 345 ppm. However, this value will vary depending on season.



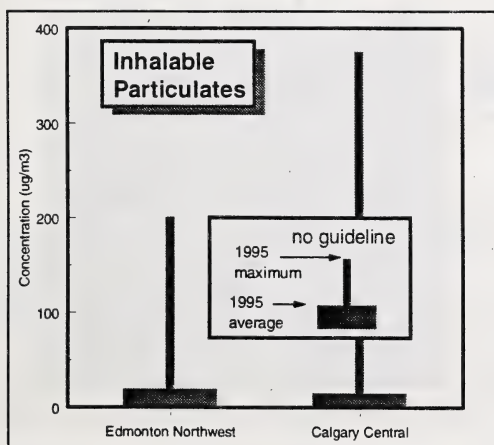
Annual Average Carbon Dioxide Concentrations (ppm)

Parameter	Monitoring Period	Calgary Central	Springbank Airport
Carbon Dioxide	1995	389	369
	1991 to 1994	388	369

Inhalable Particulates

Inhalable particulates, or PM_{10} , refers to particles that have a diameter of less than 10 microns and are suspended in the air for an indefinite period of time. In Alberta, sources of inhalable particulates include soil, road dust, dust resulting from other human activities (e.g. harvest), smoke from forest fires, smoke from recreational sources (e.g. campfires and fireplaces), vehicle exhaust emissions, and industrial emission sources (e.g. power plants, cement manufacturing facilities, coal mining operations, and the forest products industry).

In 1995, inhalable particulates were monitored continuously at the Edmonton northwest and Calgary central monitoring stations. Monitoring for inhalable particulates began in June at the Calgary central station. The annual average inhalable particulate concentrations at the Edmonton northwest and Calgary central stations were 20.0 and $13.5 \mu\text{g}/\text{m}^3$ (June to December), respectively. The maximum 1-hour average concentrations at these two stations were 201 and $183 \mu\text{g}/\text{m}^3$, respectively. The annual average inhalable particulate concentration at the Edmonton northwest station was slightly lower than the average recorded in 1994 ($21.7 \mu\text{g}/\text{m}^3$). The major sources of inhalable particulates at these locations are vehicle exhaust emissions and residual sand and dust from winter road sanding.



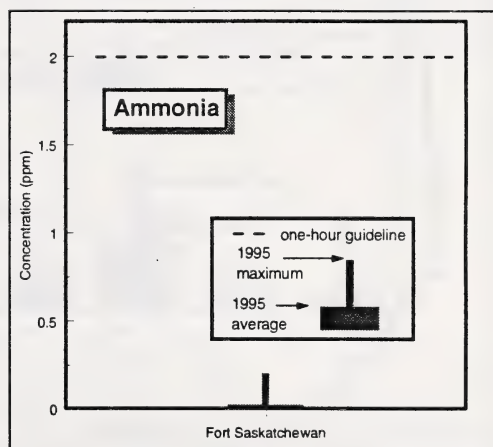
Ammonia

Ammonia is a colourless gas with a pungent odour. Ammonia is emitted into the atmosphere through natural sources such as the deterioration of plant and animal matter, and man-made sources such as the fertilizer industry.

The guideline for maximum permissible ammonia concentrations is:

- ▲ *2.0 ppm as a 1-hour average concentration.*

Ammonia is monitored at Fort Saskatchewan because of its proximity to the fertilizer industry. Ammonia concentrations were very low at the Fort Saskatchewan station in 1995. Concentrations were below the detection limit of the monitoring instrument close to 99% of the time. The overall maximum ammonia concentration was 0.2 ppm which is 10% of the 1-hour guideline. The annual average ammonia concentration at the Fort Saskatchewan station in 1995 was lower than the 10-year average.



Annual Average Ammonia Concentrations (ppm)

Parameter	Monitoring Period	Fort Saskatchewan
Ammonia	1995	0.00
	1982 to 1991 ^a	0.01

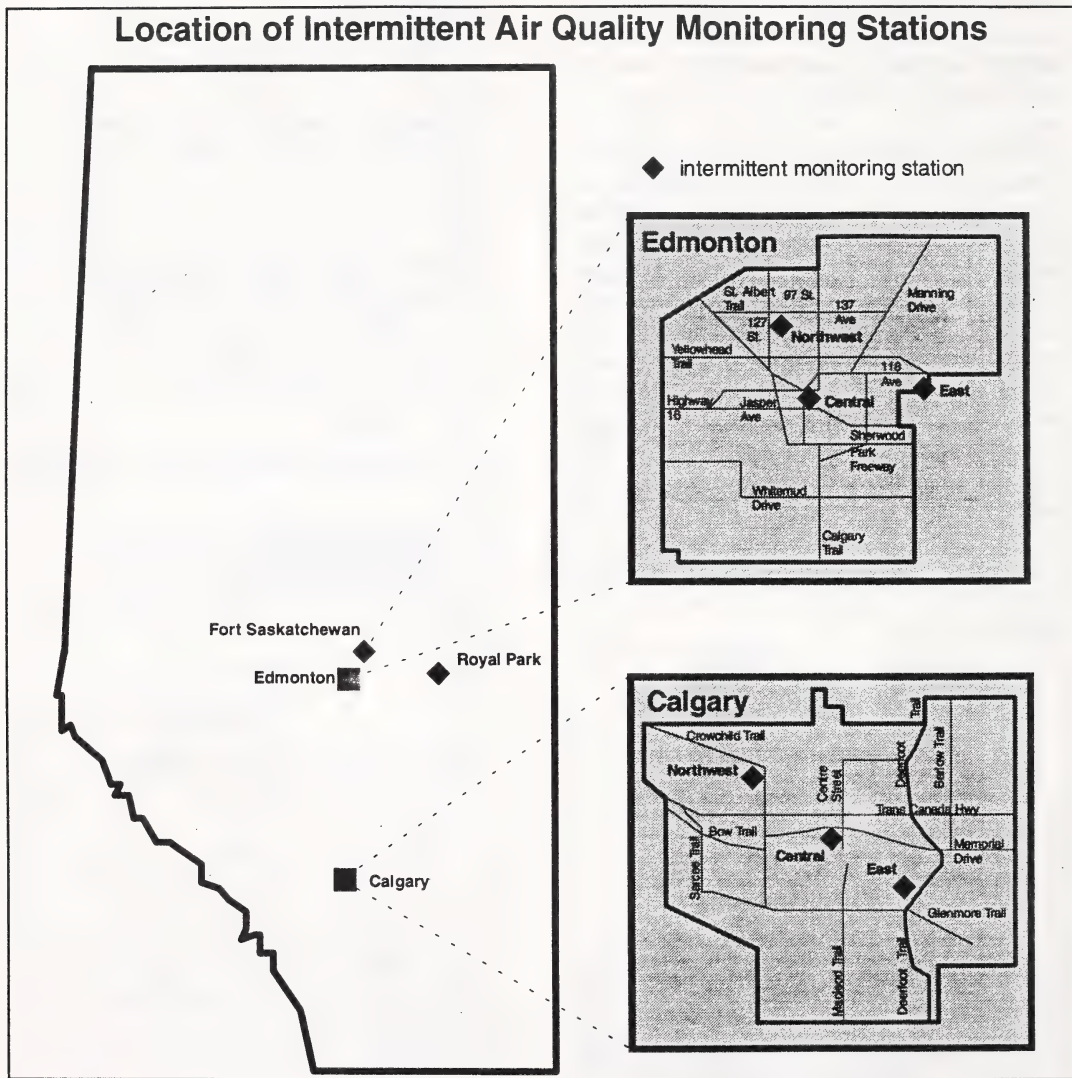
^a ammonia not monitored from 1992 to 1994

INTERMITTENT AIR QUALITY MONITORING

Intermittent air quality monitoring refers to air pollutants which are monitored as a 24-hour integrated concentration, once every sixth day,

in accordance with the National Air Pollution Surveillance (NAPS) monitoring schedule. In 1995, intermittent monitoring was conducted at 8 stations located in Edmonton (three stations), Calgary (three stations), Fort Saskatchewan, and Royal Park. Parameters collected at these stations included suspended particulates, benzo (a) pyrene, sulphates and nitrates.

Location of Intermittent Air Quality Monitoring Stations



Total Suspended Particulates

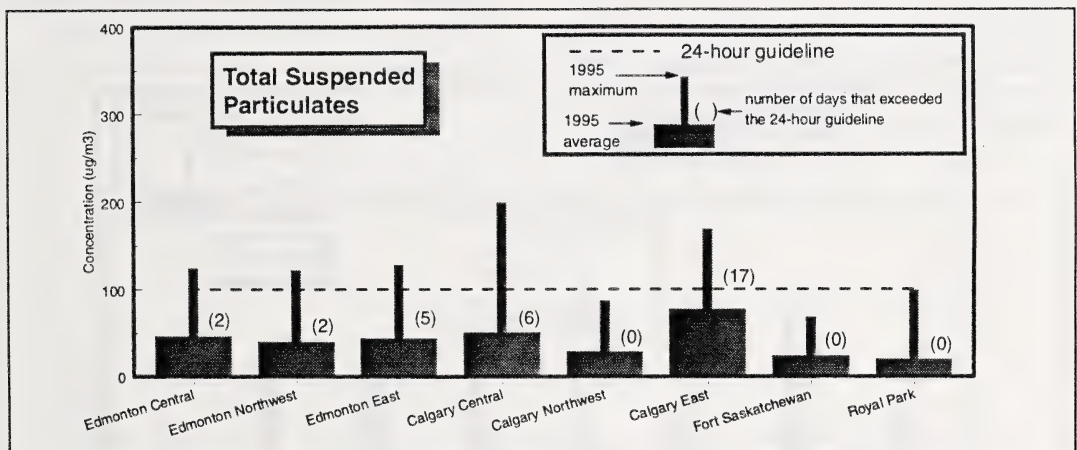
Suspended particulates are particles which range from about 0.001 to 500 microns in diameter (a human hair is about 100 microns in diameter) and, depending on their density, may remain suspended in the air for an indefinite period of time. In general, suspended particulates may originate from: soil, road and agricultural dust; smoke from forest fires and recreational fires; vehicular exhaust emissions; and industrial sources (e.g. cement manufacturing, wood processing, coal processing and power generation).

The guidelines for total suspended particulates are based on nuisance effects. Alberta Environmental Protection has adopted the following federal standards for total suspended particulate loadings:

- ▲ 100 $\mu\text{g}/\text{m}^3$ as a 24-hour total loading; and
- ▲ 60 $\mu\text{g}/\text{m}^3$ as an annual average loading.

The 24-hour guideline for total suspended particulates was exceeded at the Edmonton central, Edmonton northwest, Edmonton east, Calgary central and Calgary east stations in 1995. The highest number of exceedances was recorded at the Calgary east station where the guideline was exceeded 17 times. The annual average guideline was also exceeded at the Calgary east station. The major sources of suspended particulates are vehicle exhaust and traffic movement on sanded streets.

Annual average suspended particulate loadings in 1995 were lower than annual average values from 1985 to 1994 at most monitoring stations. Annual average values in downtown Edmonton and Calgary were from 20 to 26% lower than the average over the past 10 years. The annual average suspended particulate loading at the Calgary east station was 4% higher than the 10-year average.

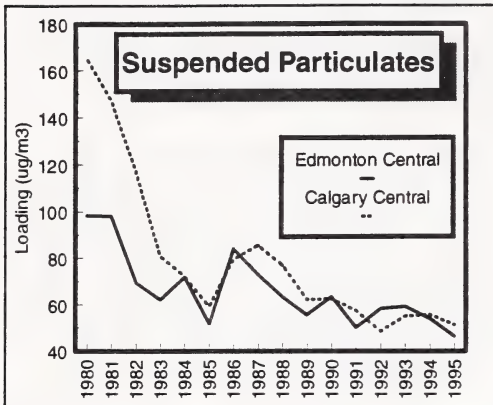


Annual Average Total Suspended Particulate Concentrations ($\mu\text{g}/\text{m}^3$)

Parameter	Monitoring Period	Edmonton			Calgary			Fort Saskatchewan	Royal Park
		Central	Northwest	East	Central	Northwest	East		
Suspended Particulates	1995	46.4	40.4	43.8	51.3	29.0	77.3	23.8	19.9
	1985 to 1994	61.1	43.1	50.3	64.1	39.3	74.2	32.2	26.9 ^a

a - Annual average suspended particulates from Royal Park for 1993 and 1994.

A significant downward trend in suspended particulate loadings is evident at the Edmonton central, Edmonton northwest, Calgary central, Calgary northwest and Fort Saskatchewan monitoring stations. These trends were most pronounced at the Edmonton and Calgary central stations.

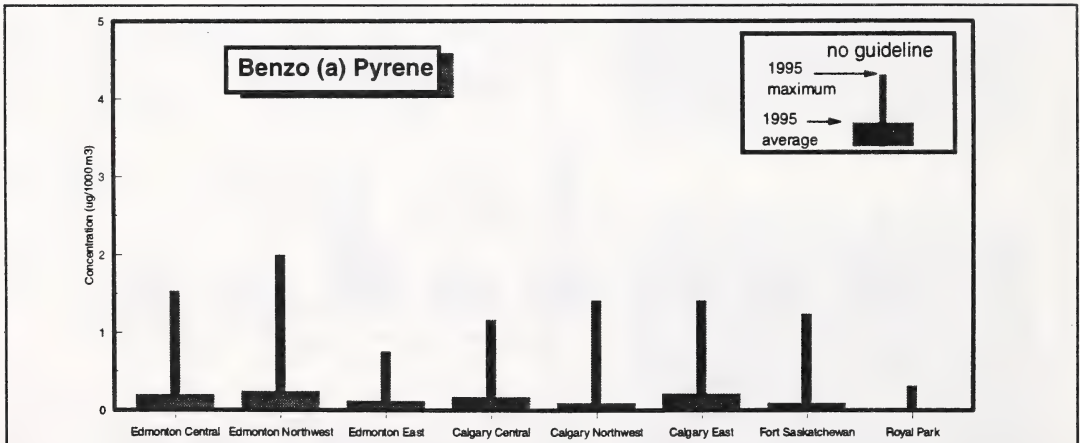


Benzo (a) Pyrene

Benzo (a) pyrene is a polycyclic aromatic hydrocarbon (PAH) that is a by-product of combustion contained in all types of soot and smoke. Vehicular exhaust, industrial combustion processes and recreational wood burning are common sources of benzo (a) pyrene. No air quality guidelines currently exist in Alberta for benzo (a) pyrene.

The highest benzo (a) pyrene loadings were recorded at the Edmonton northwest, Edmonton central and Calgary east stations. Vehicle emissions are the major source of benzo (a) pyrene at these stations.

Benzo (a) pyrene concentrations were 25 to 30% lower in 1995 than the average over the previous 10 years at the Edmonton and Calgary central stations. However, benzo (a) pyrene values higher than the 10-year average were recorded at the Edmonton northwest, Edmonton east, Calgary northwest, Calgary east and Fort Saskatchewan stations.

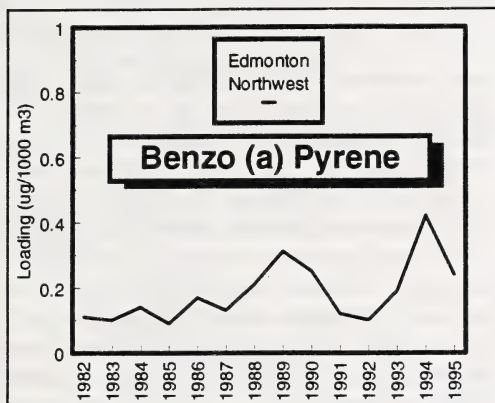


Annual Average Benzo (a) Pyrene Concentrations (ug/1000m³)

Parameter	Monitoring Period	Edmonton			Calgary			Fort Saskatchewan	Royal Park
		Central	Northwest	East	Central	Northwest	East		
Benzo (a) Pyrene	1995	0.20	0.24	0.12	0.17	0.09	0.21	0.09	0.01
	1985 to 1994	0.27	0.20	0.07	0.25	0.07	0.18	0.06	0.01 ^a

a Annual average benzo (a) pyrene from Royal Park for 1994.

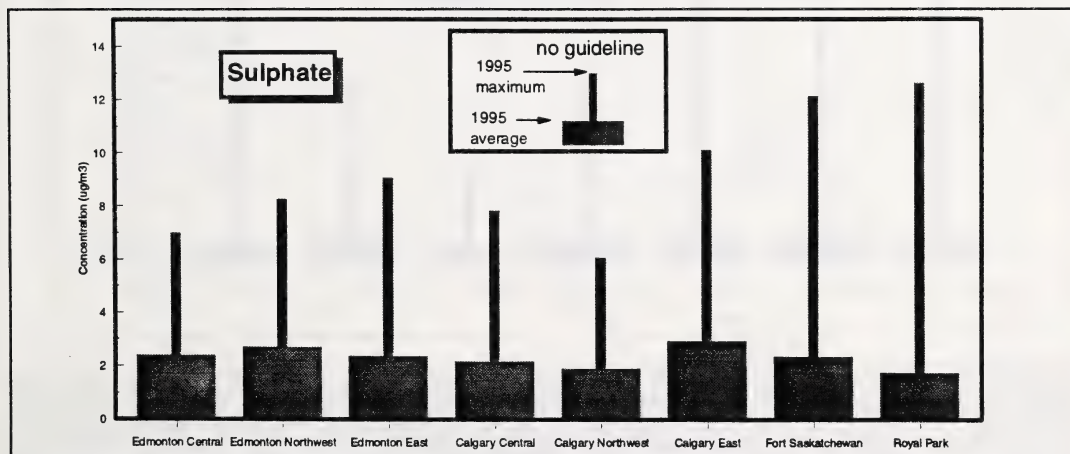
A significant dip in benzo (a) pyrene concentrations is evident in 1991 and 1992 at most urban monitoring stations. This dip may be related to modifications in analytical methods. A small upward trend in long-term benzo (a) pyrene values is evident at the Edmonton northwest station.



Sulphate

Sulphate is formed by the oxidation of sulphur dioxide and other sulphur compounds. The primary sources of sulphur compounds include natural gas processing facilities, oil sands facilities, power plants, oil refineries, pulp and paper mills, fertilizer plants, sulphur hot springs, sloughs and swamps. Dust from sulphur-containing rocks and soil is a common natural source of particulate sulphate.

The highest annual average sulphate concentrations were reported at the Calgary east and Edmonton northwest monitoring stations. Relatively high sulphate values were also recorded at other urban stations located in Edmonton, Calgary and Fort Saskatchewan. The highest peak sulphate concentrations were recorded at the Royal Park and Fort Saskatchewan stations. Sulphate loadings were higher at all Alberta stations from 1993 to 1995 compared to values measured from 1985 to 1987. This increase may be due to changes in laboratory analysis procedures. Total suspended particulate samples were not analyzed for sulphates from 1988 to 1992. Sulphate in suspended particulates has not been monitored for a long enough period to resolve a significant trend.



Annual Average Sulphate Concentrations ($\mu\text{g}/\text{m}^3$)

Parameter	Monitoring Period	Edmonton			Calgary			Fort Saskatchewan	Royal Park
		Central	Northwest	East	Central	Northwest	East		
Sulphate	1995	2.40	2.7	2.38	2.19	1.90	2.92	2.35	1.76
	1985 to 1994 ^a	1.69	1.57	1.76	1.89	1.42	2.10	1.83	1.50 ^b

a Total suspended particulate samples not analyzed for sulphate from 1988 to 1992, inclusive.

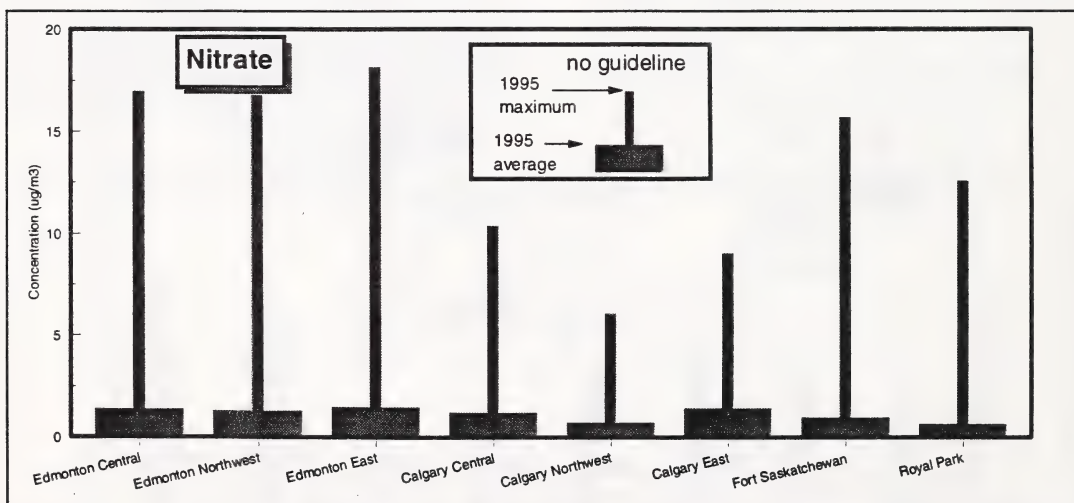
b Annual average sulphate from Royal Park for 1993 and 1994.

Nitrate

Nitrates are formed by the oxidation of oxides of nitrogen and nitrogen compounds. The major sources of oxides of nitrogen in Alberta are natural gas processing facilities, transportation, power plants, oil sands plants, natural gas and heating fuel use, agricultural fuel use, forest fires, fertilizer plants and nitric acid plants. Wind-blown dust and soil will also contain particulate nitrate.

The highest annual average nitrate concentrations were recorded at the Calgary east and Edmonton

east monitoring stations. Relatively high average nitrate concentrations were also recorded at the Edmonton central, Edmonton northwest and Calgary central stations. As with sulphate, nitrate concentrations at all stations were higher in 1993 to 1995 than values recorded from 1985 to 1987. Again, this discrepancy may be attributed to changes in laboratory analytical procedures. Total suspended particulate samples were not analyzed for nitrates from 1988 to 1992. Nitrates have not been monitored for a long enough time to resolve significant trends.

Annual Average Nitrate Concentrations ($\mu\text{g}/\text{m}^3$)

Parameter	Monitoring Period	Edmonton			Calgary			Fort Saskatchewan	Royal Park
		Central	Northwest	East	Central	Northwest	East		
Nitrate	1995	1.38	1.30	1.48	1.22	0.74	1.44	0.97	0.66
	1985-1994 ^a	1.02	0.88	0.98	1.08	0.70	1.08	0.74	0.46 ^b

a Total suspended particulate samples not analyzed for nitrate from 1988 to 1992, inclusive.

b Annual average nitrate from Royal Park for 1993 and 1994.

STATIC AIR QUALITY MONITORING

In 1995, static air quality monitoring was conducted at 31 networks from January to June by Alberta Environmental Protection. Each network consisted of at least one monitoring station.

Static monitoring is the measurement of total accumulated loadings of a pollutant on a one- and three-month schedule. This type of air quality monitoring is useful as a simple, inexpensive indicator of trends. Parameters monitored on a static basis include total sulphation, hydrogen sulphide, dustfall, calcium and fluorides.

Location of Static Air Quality Monitoring Networks

Map Location	Network Location
1	Blairmore
2	Calgary
3	Camrose
4	Coleman (2 networks)
5	Edmonton
6	Fort Saskatchewan
7	Medicine Hat
9	Sherwood Park
10	Balzac
15	Cochrane
16	Carstairs
17	Crossfield
18	Diamond Valley
21	Edson
22	Fort McMurray *
23	Grande Prairie
24	Hinton
27	Jumping Pound
30	Lone Pine Creek
32	Mazeppa
35	Okotoks
37	Pincher Creek
38	Quirk Creek
41	St. Albert
45	Waterton
48	Lethbridge
49	Raven Brood *
50	Redwater (2 networks)
51	Exshaw

a Operated from January to December, inclusive.



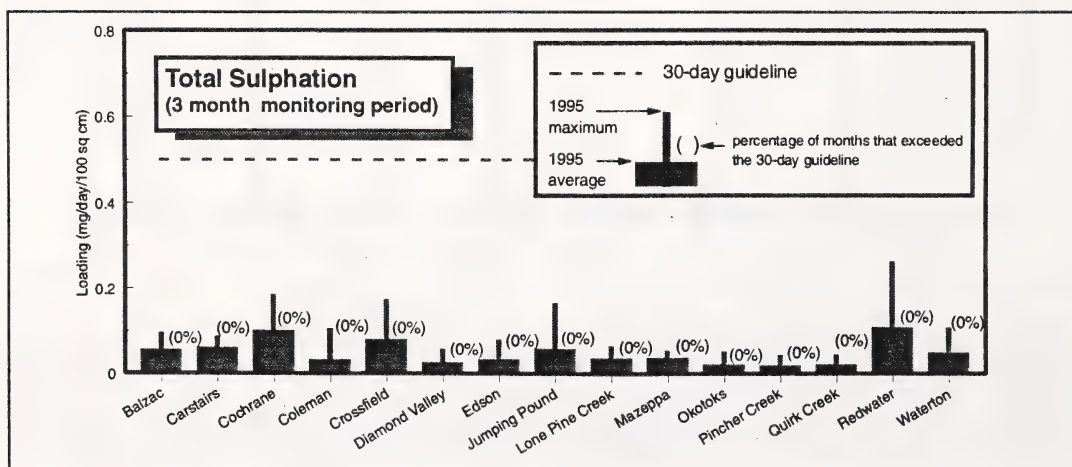
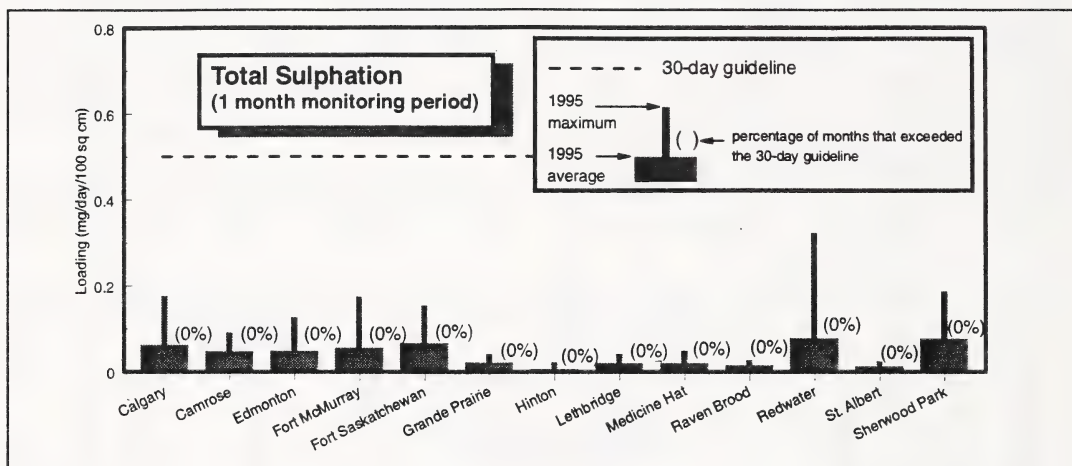
Total Sulphation

Total sulphation is the measurement of sulphur-containing compounds which exist in the atmosphere. Sulphur recovery gas plants, coal-burning power plants, oil sands plants and petroleum refineries are common sources of these gases.

The guideline for total sulphation loading in Alberta is:

- ▲ 0.50 mg SO₃ equivalent/day/ 100 sq cm.

Exceedances of the guideline for total sulphation did not occur at any static monitoring networks in 1995. The highest annual average values were recorded at the Redwater and Cochrane networks. Downward trends in total sulphation are indicated for the Calgary, Camrose, Grande Prairie, Lethbridge, Redwater, Balzac, Cochrane, Crossfield, Jumping Pound, Lone Pine Creek and Okotoks networks.



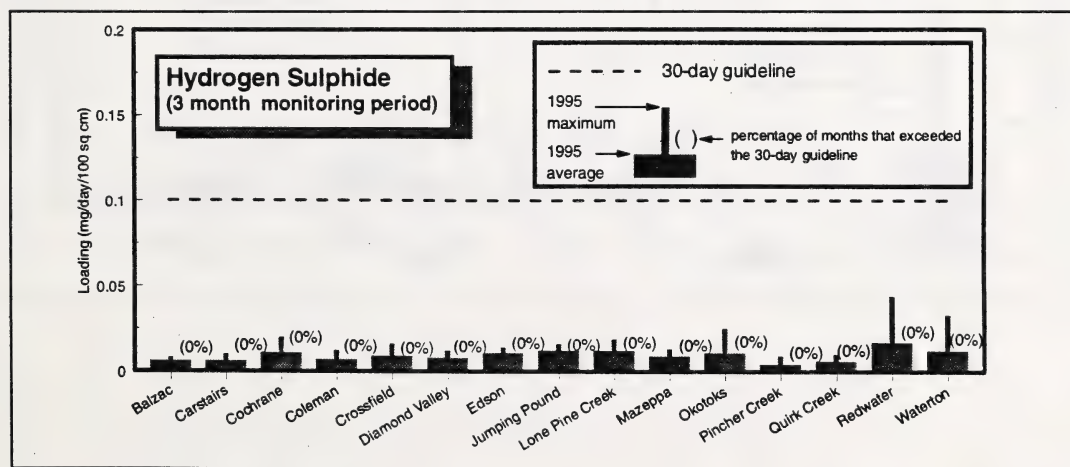
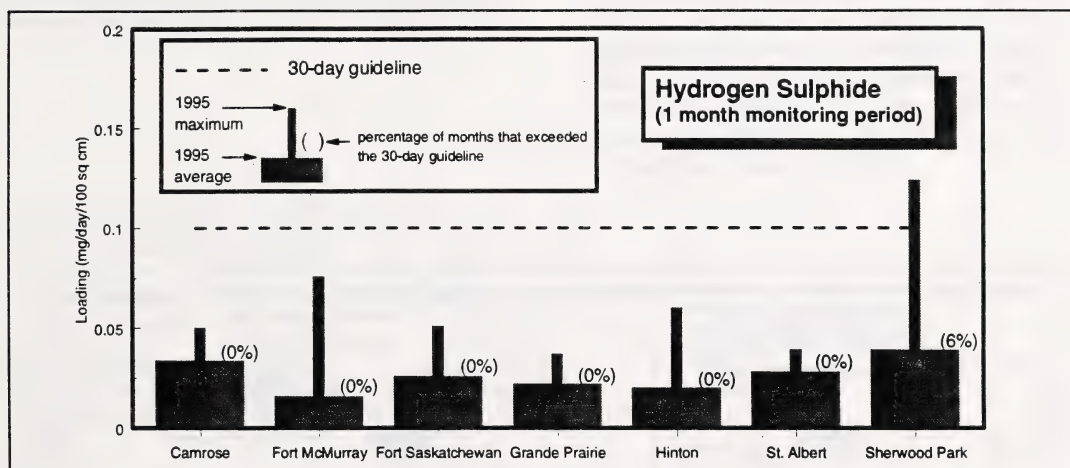
Static Hydrogen Sulphide

Hydrogen sulphide is present in the atmosphere from natural sources such as coal, natural gas, oil, sulphur hot springs, sloughs, swamps and lakes. Industrial sources of hydrogen sulphide include petroleum refining plants, natural gas plants, petrochemical complexes, oil sands plants, pulp and paper plants employing the kraft pulping process, and petroleum and gas gathering fields.

The guideline for hydrogen sulphide loading in Alberta is:

▲ $0.10 \text{ mg SO}_3 \text{ equivalent/day/100 sq cm}$.

The guideline for static hydrogen sulphide was exceeded 6.0% of the time at the Sherwood Park network in 1995. Exceedances were not recorded at other hydrogen sulphide networks. An upward trend in long-term (1980 to 1995) annual average hydrogen sulphide values is evident at the Coleman network. A significant trend is not apparent at any other static hydrogen sulphide networks.



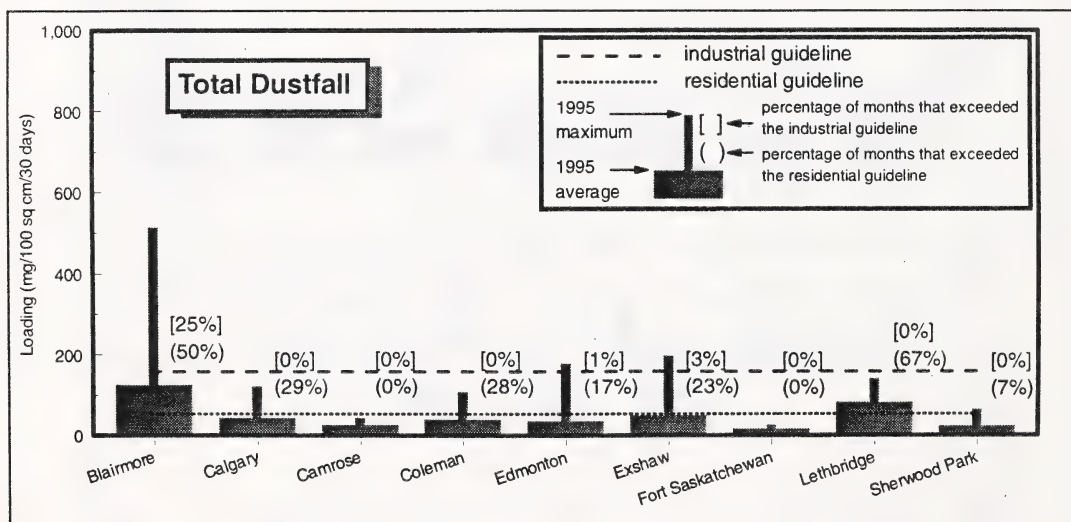
Total Dustfall

Dustfall is particulate matter which is too heavy to remain suspended in the atmosphere indefinitely. Sources of dustfall include wind-blown soil, road dust, dust generated by agricultural activities, ash from forest fires and recreational fires, and flyash from industrial sources.

The Alberta Environmental Protection guidelines for total dustfall loadings are:

- 53 mg/100 sq cm/30 days in residential and recreational areas;
- 158 mg/100 sq cm/30 days in commercial and industrial areas.

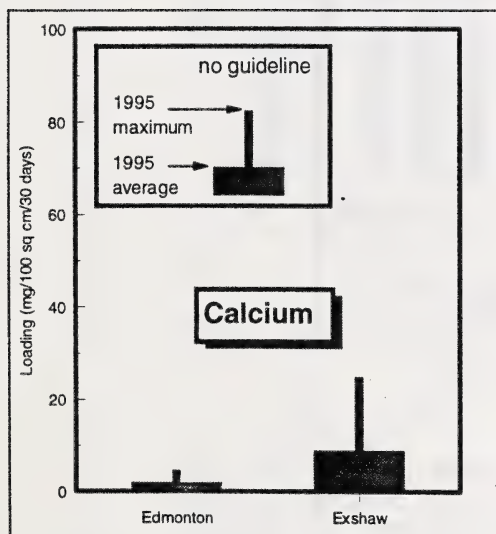
With the exception of the Fort Saskatchewan and Camrose networks, total dustfall loadings exceeded the monthly residential guidelines at all dustfall networks. The highest annual average dustfall values were recorded at the Blairmore and Lethbridge networks. A downward trend in dustfall loadings is evident at the Blairmore, Coleman, Edmonton, Exshaw, and Sherwood Park networks. The major sources of dustfall in Alberta include road dust, agricultural dust, dust from industrial sources (e.g. cement manufacturing operations, coal mining operations, wood manufacturing facilities and coal-fired power plants), and vehicular exhaust.



Calcium

Calcium emanates from natural sources such as wind-blown soil and road dust. Man-made sources of calcium in dustfall include cement, iron, steel and wood processing. There are no guidelines for atmospheric loadings of calcium in Alberta.

The highest monthly and annual average calcium loadings were recorded at the Exshaw network in 1995. A downward trend in calcium loadings is indicated at the Exshaw network based on data from 1980 to 1995. The major sources of calcium in the Exshaw area are cement manufacturing operations and wind blown dust.



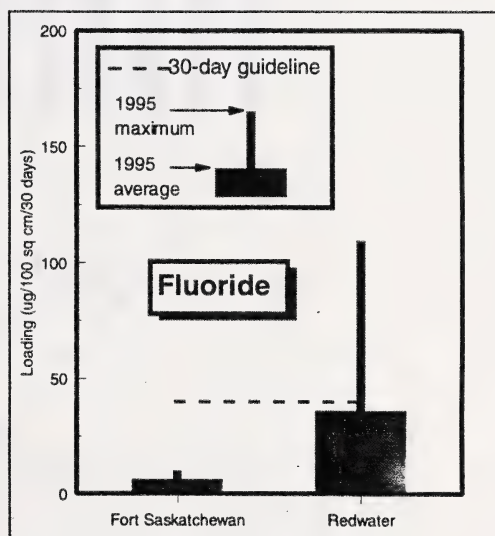
Fluoride

Fluorides are emitted into the atmosphere through processes such as coal combustion and the processing of phosphate bearing rock primarily used in the fertilizer production industry.

The Alberta Environmental Protection guideline for fluoride loading is:

- ▲ 40.0 ug water soluble fluorides/100 sq cm/30 days

In 1995, the guideline for fluorides was exceeded 29% of the time at the Redwater monitoring network. High loadings in the Redwater area are likely due to ammonium phosphate fertilizer manufacturing operations. A downward trend in fluoride loadings is evident at the Fort Saskatchewan monitoring network.

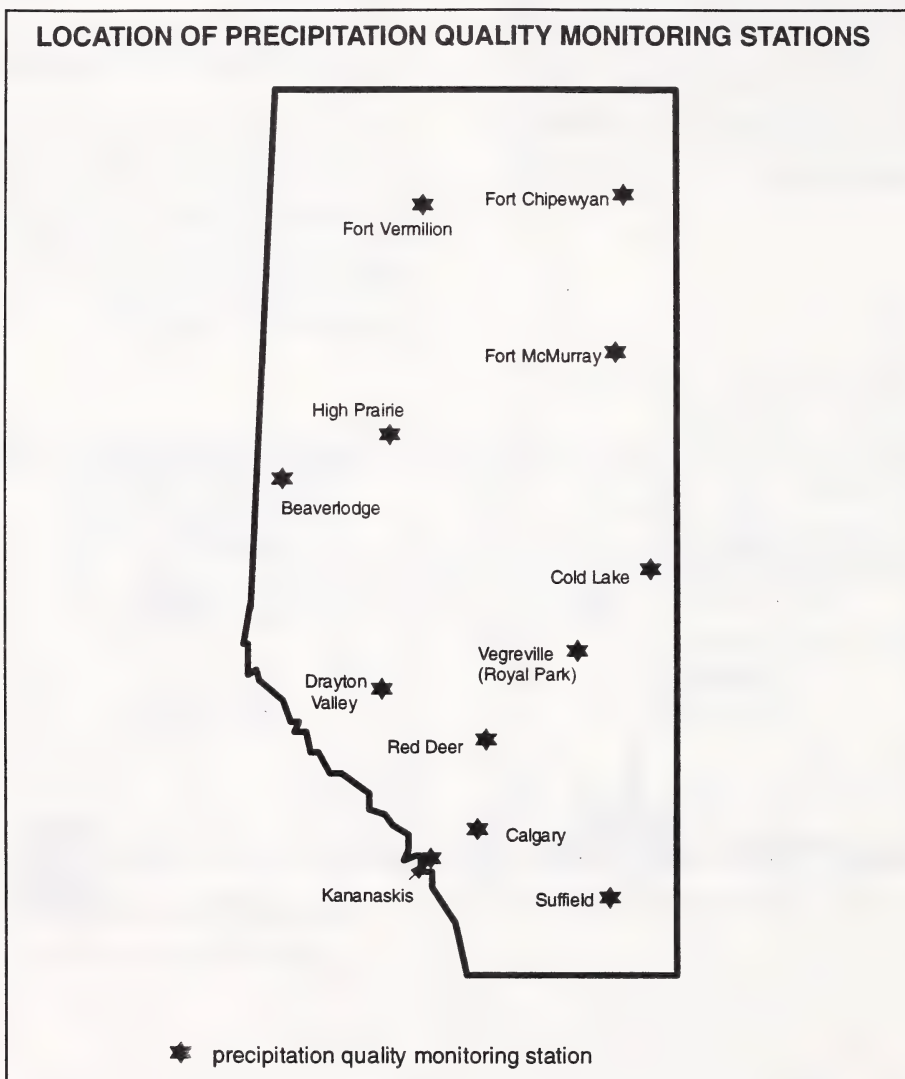


PRECIPITATION QUALITY MONITORING

Rain and snow samples were collected, on a weekly basis, at 12 locations in the province by Alberta

Environmental Protection in 1995. Chemical analysis was conducted on these samples to obtain pH as well as other ions contained in precipitation. The effective acidity and potential acid input of the precipitation was also calculated. Deposition guidelines for acid precipitation are currently being developed by Alberta Environmental Protection.

LOCATION OF PRECIPITATION QUALITY MONITORING STATIONS



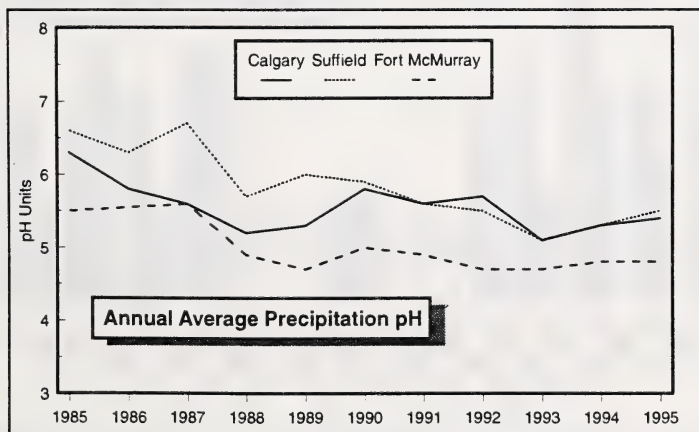
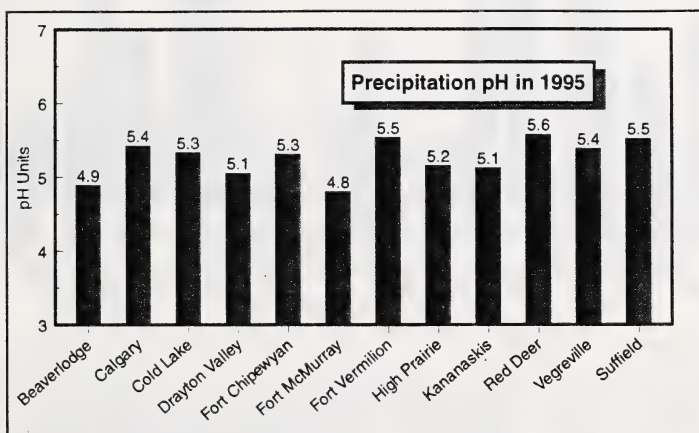
pH

The most acidic (lowest pH) precipitation in 1995 was recorded at the Fort McMurray precipitation monitoring station where an annual average pH value of 4.8 was observed. Precipitation pH ranged from 4.9 to 5.6 at other precipitation quality stations. The pH of uncontaminated precipitation is near 5.0.

Based on an analysis of precipitation samples collected from 1985 to 1995, average pH values ranged from 5.0 at Fort McMurray to 5.8 at Suffield. Annual average precipitation pH values of 5.2 or less were recorded at the Beaverlodge,

Drayton Valley, Fort Chipewyan and Kananaskis stations over this time period. The precipitation pH on a province wide basis is 5.3 based on data collected from 1985 to 1995.

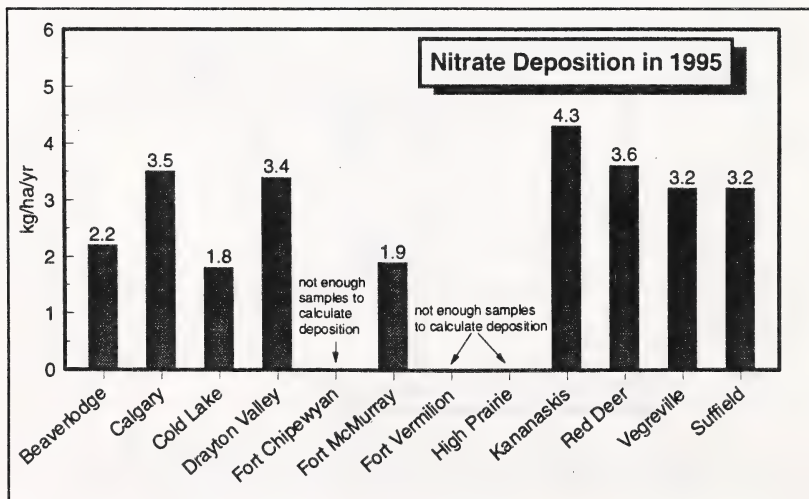
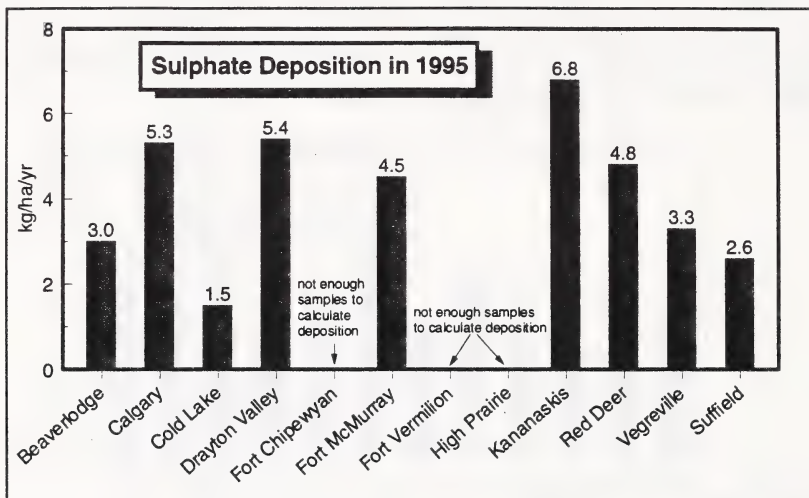
A slight decrease in pH values is evident at several monitoring sites based on data from 1985 to 1995. This decrease is most pronounced at the Suffield precipitation station. Lower pH values (or increased acidity) may be caused by improved sampling techniques, a change in the location of the monitoring site, or regional increases in acidifying emissions.



Anions (sulphate, nitrate, chloride and phosphate)

Anions in precipitation may result from emissions into the atmosphere from coal-fired power plants, oil refineries, gas plants, oil sands plants, pulp and paper plants, fertilizer plants, vehicular emissions and agricultural activities. Alberta Environmental Protection does not have guidelines for anions in precipitation.

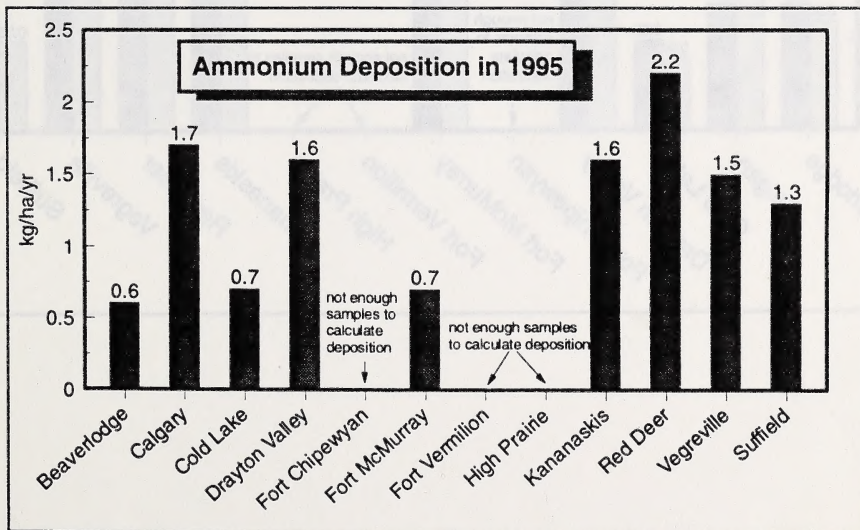
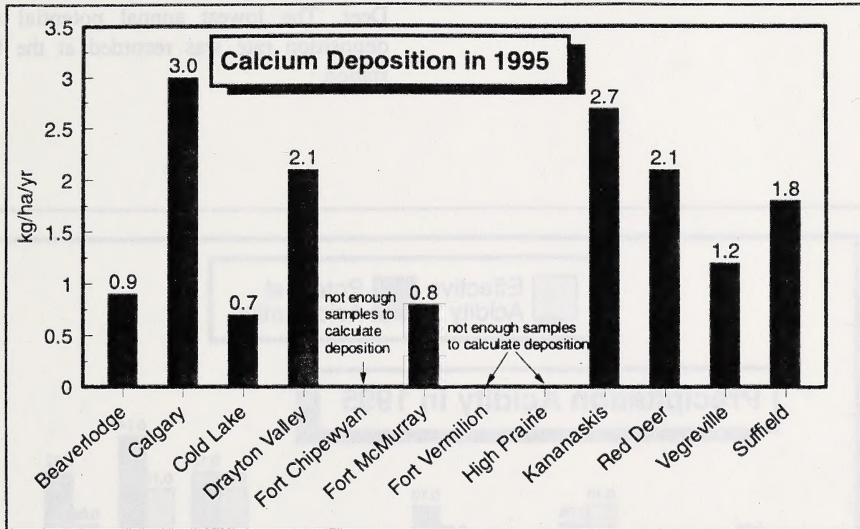
The highest sulphate and nitrate deposition rates were recorded at the Kananaskis precipitation station in 1995. Chloride and phosphate wet deposition rates were relatively low at all monitoring stations.



Cations (calcium, ammonium, sodium, magnesium, potassium)

Cations may originate from industrial sources such as iron and steel manufacturing, wood processing, or natural sources such as wind-blown soil and dust. There are currently no guidelines for cations in precipitation in Alberta.

Calcium concentrations in precipitation were highest at the Calgary and Kananaskis stations. The highest annual ammonium deposition rate was recorded at the Red Deer station. Wet deposition rates of sodium, magnesium and potassium were at or below 1.0 kg/ha/yr at all precipitation quality stations.



Effective Acidity

Effective acidity is an approach which has been developed to estimate the amount of acidity produced in the soil due to physical, chemical and biological processes which occur as a result of acid deposition. In 1995, the highest annual effective acidity deposition rate occurred at Red Deer and Kananaskis where values of 0.11 kg(of H⁺)/ha/yr was calculated. The minimum value calculated was 0.04 kg(H⁺)/ha/yr at Cold Lake.

Potential acid input

Potential acid input is described as the sum of base cation deposition (calcium, magnesium, and potassium) subtracted from the sum of the total sulphur and nitrogen deposition. The result of this equation is an estimate of the total acid input into the ecosystem. Potential acid input values were similar to effective acidity values at all stations. A maximum annual potential acid input deposition rate of 0.14 kg(of H⁺)/ha/yr was measured at Red Deer. The lowest annual potential acid input deposition rate was recorded at the Cold Lake station.

